

1995 Charter School Application

UMASS/AMHERST

UMASS/AMHERST



312066 0374 5539 7

Basic Fact Sheet

the Executive Office of Education to conduct quick analysis of the applications received. It must be accurate, and must correspond to that which is provided in the body of the proposal. Reviewers at the Executive Office of Education with a snapshot of your proposal.

Chelmsford Public Charter School*

*This name will likely change

Proposed Charter School Name

Chelmsford, MA

School Location (city/town)

Contact Person

First Nina Middle S. Last LewinOrganization Chelmsford Alliance for Education Address P.O. Box 152City Chelmsford, State MA Zip 01824Telephone (508) 256-8800 or (508) 256-4701 Fax (508) 256-4231

Founding Coalition:

(Check Box)

Private
For-Profit

Parents

Teachers

Business

☐☐☐Community
BasedOther
Founding
Group

Organization Museum

☒☐☐

Grade Level

(Check Box)

Elementary

☐

Middle

☒

Secondary

☐

Other

Grade

Level

☐

Projected Student Enrollment

Projected Student Enrollment (1st Year) 88

Projected Student Enrollment (2nd Year) 132

Projected Student Enrollment (3rd Year) 132

Projected Student Enrollment (4th Year) 132

Projected Student Enrollment (5th Year) 132

Total Number of Teachers 4 to 6

Teacher/Student Ratio 1/22

In what type of community will
the Charter School be located?

Urban School District

☐

Rural School District

☐

Suburban School District

☒

Other Kind of Community

☐Do you presently have access to
a facility suitable for a school?

Yes

☐

No

☒

School Focus:

In succinct terms, describe the focus and primary characteristics of your proposed school and/or students to be served, (i.e., math & science, arts, school-based services, at-risk youth, college preparatory, basic skills, interdisciplinary learning, and competency-based learning).

The charter school for 6th, 7th and 8th graders will provide a learner-centered, hands-on, technologically integrated, interdisciplinary environment using systems dynamics as a focal point. Home-school-community partnerships will be an integral part of the school.

Executive Summary (one page):

To help the Executive Office of Education accurately portray your charter school proposal to the public, please attach a one page description of your school. This description should outline, in clear terms, the educational model to be employed; the replicability of that model; student demographics; and other characteristics setting this school apart from other traditional public schools. Above all, this summary should capture the vision of the founders.

RECEIVED

FEB 15 1995

Executive Summary

The Chelmsford Public Charter School will focus on making learning relevant for its students through practical, hands-on applications of higher level knowledge.

The core values are:

- Students should be challenged to approach their maximum potential as social and intellectual individuals.
- Comprehensive learning is best achieved through hands-on participatory instruction.
- Education must constantly adapt to an ever-changing world.
- Education at this level should produce enthusiastic, life-long learners.
- Effective administration of education must include continual reassessment of curriculum, teaching methods and student and teacher performance.
- Critical thinking, problem solving and examination of problems through systems analysis are the basic foundations of learning which will carry students into the 21st century.
- Community and parental involvement are essential to student success.
- Anything worth doing is worth doing well.
- Social and emotional development at this age level are as important as academic development.

Systems Thinking and Systems Dynamics, as articulated by Jay Forrester and Peter Senge, among others, will provide a conceptual framework and guiding force in the development of curriculum. Systems dynamics encourages learners to look beyond just the facts and focus on broader principles. It is widely used in the business world and it is being successfully pioneered in some school systems around the country. Individual learning will be important, but students will also be expected to work with peers to analyze complex relationships.

Chelmsford is a predominantly Caucasian, middle class suburban community with only 17% of its households having school aged children.

Our charter school organizational structure would be very similar to the public schools:

- Class size will be about the same.
- The grade levels will reflect those of the public schools.
- The curriculum is comprehensive.
- Budgetary requirements are the same.

The replicability of the charter school will be ensured by:

- The home-school partnership as a driving force for effecting change.
- Dialogue with the public school administration and school committee.
- Maintaining high visibility and open communication with the community and the school administration.
- As the cornerstone of the charter school depends upon teacher as facilitator and teachers being fully trained in systems dynamics, they will necessarily bring those skills and attitudes with them when they return to the public schools.

TABLE OF CONTENTS

| | |
|--|----|
| 1. Mission Statement..... | 1 |
| A. In succinct terms, describe the core philosophy or underlying purpose of the proposed school..... | 1 |
| B. As a charter school, your school will be a "laboratory of innovation" in the State's larger education reform effort. With this in mind, what impact do you hope your charter school will have on the state of public education in the Commonwealth of Massachusetts?..... | 1 |
| 2. School Objectives..... | 2 |
| A. What are the school's broad academic objectives for student learning?..... | 2 |
| B. Describe any non-academic goals for student performance..... | 2 |
| 3. Statement of Need..... | 7 |
| A. Why is there a need for this type of school?..... | 7 |
| B. Explain why the charter school model would be an appropriate vehicle to address this need..... | 7 |
| 4. Profile of Founding Coalition..... | 8 |
| A. Describe the make-up of the group or partnership that is working to apply for a charter, including the name of the founders and their backgrounds and experiences..... | 8 |
| B. Discuss how the group came together, as well as any partnership arrangements with existing schools, educational programs, businesses, non-profits or any other entities or groups..... | 8 |
| C. Include any plans for further recruitment of founders or organizers of the school..... | 9 |
| 5. School Demographics..... | 10 |
| A. Describe the area where the school will be located..... | 10 |
| B. Why was this location selected? Are there other locations suitable to the needs and focus of the school?.... | 10 |
| C. Describe any unique demographic characteristics of the student population to be served..... | 10 |
| D. What are the school's enrollment projections for the first five years? What is the school's ultimate enrollment goal?..... | 10 |
| E. What grade levels will be served? How many students are expected in each grade or grouping?..... | 11 |
| 6. Recruiting and Marketing Plan..... | 11 |
| A. Demonstrate how you will publicize the school to attract a diverse pool of applicants..... | 11 |
| B. What type of outreach will be made to potential students and their families?..... | 11 |
| C. Describe efforts to recruit students without parents to advocate on their behalf..... | 11 |



Digitized by the Internet Archive
in 2013 with funding from
Boston Library Consortium Member Libraries

<http://archive.org/details/1995charterscho00mass>

| | |
|---|----|
| 7. Admissions Policy..... | 12 |
| A. Describe the admission methods and standards you will use to select students..... | 12 |
| B. Describe the process and timetable to be used for admitting students, including a plan for the admission lottery for students both within and outside the district..... | 12 |
| C. Explain how these policies further the mission of the school in a non-discriminatory fashion..... | 13 |
| 8. Timetable..... | 13 |
| Provide a detailed timetable of projected steps and dates leading to the opening of a charter school..... | 13 |
| 9. Evidence of Support..... | 14 |
| A. Try to convey as clearly as possible the scope of community backing for the proposed charter school..... | 14 |
| B. In tangible terms, such as survey or letters of support, demonstrate this community support among teachers, parents, students, community leaders and others..... | 15 |
| 10. Educational Program..... | 15 |
| A. Describe the educational program of the school, providing a detailed overview of curriculum objectives and content in the main subject areas..... | 15 |
| B. What teaching methods will be used? How will this pedagogy enhance student learning?..... | 18 |
| C. Describe the school calendar and hours of operation of the school..... | 19 |
| 11. Student Performance..... | 19 |
| A. Describe your proposed plan to assess student performance..... | 19 |
| B. What remediation will be available for underperforming students?..... | 20 |
| C. How will student development towards the school's stated learning objectives be measured?..... | 20 |
| 12. Accountability..... | 20 |
| A. What methods of self-assessment or evaluation will be used to ensure that the school is meeting its stated mission and objectives?..... | 20 |
| B. How will teachers and administrators be evaluated? Describe your standards for teacher and staff performance..... | 21 |
| C. How do you plan to hold your school accountable to the public and parents of the children in attendance at your school?..... | 21 |
| D. Discuss your plan for regular review of school budgets and financial records..... | 22 |
| E. Describe your system for maintaining school records and disseminating information required under public school law, including the annual report, as set forth in M.G.L. c.71,s89..... | 22 |

| | |
|---|----|
| 13. Human Resource Information..... | 23 |
| A. Describe the standards to be used in the hiring process, including teacher certification requirements or any other professional credentials..... | 23 |
| B. What is the targeted staff size and teacher/student ratio?..... | 23 |
| C. What professional development opportunities will be available to teachers and other staff?..... | 24 |
| D. Describe your human resource policies governing: salaries, contracts, hiring and dismissal, benefit packages..... | 24 |
| 14. School Governance..... | 24 |
| A. Describe the internal form of management to be implemented at your school , including any plans to contract with an outside group to manage the school..... | 24 |
| B. How will the Board of Trustees be chosen?..... | 25 |
| C. Describe the roles and responsibilities of the Board..... | 25 |
| D. Describe the relationship of the board to teachers and administrators..... | 25 |
| E. Discuss the nature of parental and student involvement in decision making matters..... | 26 |
| 15. School Community..... | 26 |
| A. What type of community environment do you hope to foster at your school?..... | 26 |
| B. Describe the nature and extent of parent involvement in the life of the school..... | 26 |
| C. Describe the relationship of your school to the surrounding community and vice versa..... | 27 |
| 16. Replicability and District Relations..... | 27 |
| A. How will your charter school offer replicable educational models to the schools in the surrounding districts?..... | 27 |
| B. If applicable, provide any specific programs to be provided by the charter school which would directly benefit the district..... | 27 |
| C. What efforts, if any, have you made to build rapport with the district from which your charter school would draw students?..... | 27 |
| 17. Building Options..... | 28 |
| A. Describe your present options for a school building..... | 28 |
| B. Demonstrate how these sites would be suitable facilities for the proposed school, including any plans to renovate and bring the facility to compliance with all applicable school building codes..... | 28 |
| C. Discuss any progress or future plans for acquisition of a school building..... | 28 |
| D. Describe financing plans, if any..... | 28 |
| 18. Code of conduct..... | 28 |
| A. Discuss any rules or guidelines governing student behavior..... | 28 |
| B. Describe your school's policies regarding student expulsion and suspension..... | 29 |

| | |
|--|----|
| 19. Special Needs and Bilingual Students..... | 29 |
| A. Describe how your school will accommodate special needs students..... | 29 |
| B. Describe how your school will accommodate bilingual students..... | 30 |
| 20. Funding..... | 30 |
| A. Devise a start-up budget covering the planning and capital expenses before school opening..... | 30 |
| B. Do you plan to conduct any fund-raising efforts to generate capital or to supplement the per pupil allocations? If so, explain..... | 30 |
| C. Using the attached template, devise a 5-year budget covering all projected sources of revenue, both public and private, and planned expenditures..... | 30 |
| 21. Transportation..... | 30 |
| A. Discuss plans for transporting students within the local district to and from school. What arrangements, if any, will be made with the local school committee?..... | 30 |
| B. How will students who live outside the district be transported?..... | 31 |
| C. If you plan to implement an extended day or extended year program which requires transportation beyond what the district provides, what arrangements will be made to transport students?..... | 31 |

Appendices

| | |
|----------------------------------|------------|
| Resumes..... | Appendix A |
| Letters of Support..... | Appendix B |
| A Day in the Life..... | Appendix C |
| Job Descriptions, Contracts..... | Appendix D |
| Budget..... | Appendix E |
| Systems Dynamics Articles..... | Appendix F |

A. In succinct terms, describe the core philosophy or underlying purpose of the proposed school.

As the world changes at lightening pace, it is vital that we prepare students adequately. The mission of the Chelmsford Public Charter School is to prepare students who are able to analyze complex systems and problems, and most importantly acquire the skills necessary to examine, analyze and adapt to the rapidly changing world they will be entering and ultimately managing. It is evident that traditional public schools are falling short due to a continued emphasis on memorization of isolated facts without practical application. The Chelmsford Public Charter School was founded on the philosophy that students of all ability levels can be effectively challenged to achieve to their maximum potential through a process of learning which is participatory (in contrast to the mainly passive approach of traditional classrooms), and will be anchored in relevancy and the application of knowledge.

The mission of the Chelmsford Charter School is to provide students with a challenging, interdisciplinary education that will prepare them for the 21st century through an emphasis on holistic learning, higher order and critical thinking skills and practical application and integration of curriculum areas.

B. As a charter school, your school will be a "laboratory of innovation" in the State's larger education reform effort. With this in mind, what impact do you hope your charter school will have on the state of public education in the Commonwealth of Massachusetts?

The founding coalition of this charter school believes that the successes we experience can be translated into success for other middle class communities across the commonwealth. In communities where it is widely accepted that public schools have failed, wholesale change is readily accepted and embraced. In established systems where the crisis is not as apparent, due to reputations built in the past, risk taking and experimentation are difficult to justify to the public. Middle class communities such as Chelmsford do not recognize their own need for educational reform. A successful model would help to spur Chelmsford and other middle class communities to experiment with alternative education plans. Successes in the charter school would help to decrease the risk associated with change, and thus speed up the process of implementation.

2. School Objectives:

A. What are the school's broad academic objectives for student learning?

The school's broad academic objectives are:

- To provide students with problem solving strategies that they can apply in all facets of their lives.
- To teach students to ascertain what questions they need to have answered to solve complex problems.
- To encourage students to cross disciplines within the traditional curriculum to produce more creative, more global, more practical, and more far-reaching solutions to problems.
- To enable students to use the scientific method of inquiry for investigation of multiple subject areas.
- To develop students as enthusiastic, life-long learners.
- To apply current technology to the learning process.
- To cover the same curriculum content areas that are covered in the public schools. This will make the transition back into the public schools at grade 9 easier.
- To challenge students of all ability levels to work towards their maximum potential.
- To teach in a way that actively involves and engages students and presents information in a manner which is meaningful and relevant to students and the world around them.
- To be able to use and apply systems dynamics to solve complex problems.
- To provide students with a variety of communication skills, including verbal, written and performance-based presentation of information.

It is the intention of the Chelmsford Charter School to incorporate the Common Core of Learning and the Curriculum Frameworks developed by the Commonwealth of Massachusetts.

B. Describe any non-academic goals for student performance.

Non-academic goals for student performance are for students to:

- Develop a sense of respect for self and others
- Gain a sense of belonging to the school, the community and the world
- Observe positive role models beyond current media stereotypes
- Acquire the ability to work both independently and cooperatively
- Participate in a strong home-school partnership
- Foster an atmosphere of ethics and integrity
- Learn to take risks and manage change

The cornerstones of the charter school (each is described in detail below) will be to:

- Proactively plan and manage for change rather than reacting to change
- Provide for a consistent environment of positive social, emotional and physical development
- Establish and nurture on-going supportive relationships between home, school and community
- Expect, foster and measure for quality in all aspects of the school community
- Incorporate developmentally appropriate practices and systems dynamics in all aspects of the school (learner-centered learning)

Proactively plan and manage for change

This charter school would be adaptable because of its size and established communication infrastructure. It will be important for each student to achieve academic excellence in his or her own right and to value and be recognized for that achievement. Because of community involvement, changes in the work place will be more readily identified and reflected in the school's curriculum and environment.

System Dynamics is a scientifically developed tool to understand and manage change. This tool is now available for use by students at the middle school level. As a result, students will learn systems to understand the nature of change within systems and how to find "leverage" points that are important for change. This understanding will give students a cognitive structure and confidence for dealing with the changing world.

Critical thinking skills and problem solving analysis will lead to the ability to apply knowledge in different contexts. A key value is placed on learning how to learn. Both the teachers and students will be encouraged in risk-taking.

Students and teachers will be given ample opportunities to work cooperatively to develop the skills needed in the work place and everyday life. However, the ability to work and achieve independently will also be stressed.

Technology is rapidly becoming a fixture in every aspect of our society. The charter school students will be able to use current technology and adapt to new technological developments. More importantly, students will learn to use technology for more effective problem solving.

Provide for consistent environment of positive social, emotional and physical development

Social and emotional development is particularly critical to this age group, to the extent that it often overshadows the learning environment. By spending effort and time on this aspect of the students' well-being, the charter school will be addressing the specific concerns of these children.

Physical prowess in traditional competitive sports is the defining characteristic of popularity in this age group. The charter school, in order to develop a level of comfort with each student's own physical development and abilities will offer a non-traditional physical education program. Non-competitive gym classes will emphasize life-time sports activities. These classes will be organized as mini-sessions and will be taught by outside experts in that field (i.e. swimming, aikido, balancing skills, yoga, dance, climbing skills, etc.). By providing different avenues for success in the physical realm, each child has the potential to be recognized for achievement. This will only add to the positive, supportive social environment of the school.

The school will be organized into small, family-type units. Each student and staff member will be assigned to this unit based on common and unique interests to provide diversity within the units. These "family meetings" will start each day on a positive, sharing theme where students and faculty can speak candidly. These groups will also be the basis of student problem solving and planning. Peer mediation proceedings would begin in this family unit, moving on to administrative intervention only when needed. A psychologist will be hired to help set up and monitor this program.

The staff, which will have expertise with this age group, will act as a resource to supervise and model appropriate behavior during lunch and recess on a rotating basis. This will allow them to take advantage of the teachable moments that exist in these less structured situations.

Establish and nurture on-going supportive relationships between the home, the school and the community

A key element to the success of this charter school will be the home-school partnership. On-going communication between these two aspects of each student's life will help to expand the community beyond the school. Linkage between home and school will take many forms. Parent participation will be required on some level, depending upon the availability and skills of the parents. Monthly meetings between staff and parents will be scheduled to discuss not only school business but pertinent educational and parental issues as well. In addition, each parent will volunteer to perform several hours of service each year, based on his or her availability and talents.

Interaction with the community of greater Chelmsford, through business partnerships and community involvement, will give the students a sense of belonging to the community in which they live as well as offering the greater community a sense that they have a stake in the local school population.

In addition, the students will utilize the community's resources in a variety of ways. Field trips to local businesses and town offices will be integrated into the curriculum. The town library will be a resource and all students will be instructed in the use of inter-library technology.

Expect, foster and measure for quality in all aspects of the school community

Anything worth doing is worth doing well. That will be a major focus of this school. We would rather focus on a smaller number of subjects, and do a thorough, complete analysis of those subjects, rather than to touch on a wide number of subjects in a cursory manner.

In an effort to have high but realistic expectations, each student will help to formulate goals for himself or herself with the aid of his or her mentor. There will also be teacher and parent input. These goals will be reviewed regularly, with on-going monitoring when necessary. The goals selected will be not only academic, but revolve around the social, emotional and physical needs of the child as well.

To develop themselves professionally and to appreciate what the students are experiencing, teachers will also participate in a goal-setting process. Students, parents, peers and administrators will participate in this process.

In order to proactively address issues, each staff member will be scheduled for a weekly meeting with his or her supervisor. This time will be utilized for discussing concerns, sharing curriculum ideas and giving support.

The above techniques, along with more formal, traditional testing, will provide for effective assessment for continual improvement. The board will also pick an outside consultant to perform a yearly observation and critique that will be used for additional improvement.

Incorporate developmentally appropriate practices in all aspects of the school

Traditionally in education, teachers are the dispensers of knowledge, and children are not active participants in their own learning. It is our intention to fully involve the child in his or her own learning through a hands-on, experiential learning process that focuses on individual strengths.

The individual goal-setting plan, as discussed above, will allow each student to meet his or her potential in a way that is relevant to him or her personally. This also lets the students' own interests, strengths and learning style determine the outcome of what they learn.

It has been shown that smaller class size is critical to the success of a developmental approach to learning. Therefore, the charter school will have groups of no more than 22 per class.

Flexible scheduling to allow for uninterrupted presentation and investigation of subject matter is a key to the success of this program. See attachment A: A Day in the Life of A Charter School Child.

Studies show that an integrated curriculum provides for more relevance, and therefore, more knowledge retention, than the standard 45 minute blocks of time devoted to separate subject areas. The curriculum for the charter school will be developed with integration at the core. Interdisciplinary themes and system dynamics will aid students in relating course work to practical application and provide a framework for relating all different subject matter to one another.

We will address the arts in the same, integrated manner. The draft of the "National Standards for Education in the Arts" states, "The arts make a contribution to education that reaches beyond their intrinsic value as direct forms of thinking. Because each arts discipline appeals to different senses and expresses itself through different media, each adds a special richness to the learning environment. As students imagine, create and reflect, they are developing both verbal and non-verbal abilities necessary for school progress. At the same time, they are developing problem-solving abilities and higher-order thinking skills. Research points towards a consistent and positive correlation between a substantive education in the arts and student achievement in other subjects and on standardized test. A comprehensive, articulated arts education program also engages students in a process that helps them develop the self-discipline, cooperation and self-motivation necessary for self-esteem and success in life." (pg. 13 The Balanced Mind: An Educational and Societal Imperative, Spring, 1994).

The charter school educational program is a comprehensive curriculum. It will revolve around mathematics, language arts, and interdisciplinary study utilizing systems dynamics.

3. Statement of Need

A. Why is there a need for this type of school?

We believe the school children of today will have jobs that we cannot even imagine in the future. We need to prepare them for the 21st century with an education that works to understand the complex world in which we live. This education should give them the tools to understand and interpret the interrelated nature of our world.

The public schools in the town of Chelmsford have enjoyed a good reputation. However, that reputation was, in large part, earned twenty to thirty years ago, and the system is, in many ways, unchanged. The world that the students of today must succeed in is quite different from that around which traditional educational systems, such as Chelmsford's, have been based. The Educational Reform Act was driven by a need to bring our schools and teaching methods into the 21st century and beyond. It is very difficult, however, to affect significant change within a system the size of the Chelmsford Public Schools. While the school administration recognizes and discusses the need for reform, there is almost no perceptible change at the classroom level. The school system is large (approximately 5000 students) and has been plagued with budget problems since proposition 2-1/2 was passed. The budget crunch has become even more significant in the last few years as student enrollment has increased. Crisis management from a budgetary perspective has become the primary focus of the school committee and central administration in recent years.

B. Explain why the charter school model would be an appropriate vehicle to address this need.

The kinds of skills required for success in the modern world include critical thinking, problem analysis, and integration of one discipline with others. The Chelmsford Charter School is based on an educational philosophy whose focus includes these kinds of skills. In addition, education will be approached in a participatory manner, providing opportunities for application of knowledge. This would allow students to understand the relevancy of study materials and better retain and be able to utilize the information.

A smaller group with a strong home-school partnership would be able to more easily and successfully implement substantial change, without the constraints of a union and a large bureaucracy, and with the cooperative support of the teaching staff and parents. A small school, like a small company, can respond to change better, can reassess itself more often and can switch gears more readily when it finds that its current methods are not completely effective.

The charter school model is appropriate for our innovative school because within Chelmsford and the surrounding middle class suburban towns, there are almost no options for alternative types of education. A charter would provide a needed option and allow for the successes of this school to be easily translated to the public school system. The design of charter schools, as public institutions, open to all students, and based in their own community, provides important options for students and parents which are not currently available in Chelmsford. It is the Chelmsford Charter School's intention that teachers trained in this innovative philosophy of education will return to the public system to disseminate the successes of these methods. For established school systems, such as Chelmsford, where there is no perceived educational crisis, a small, successful model can reduce the risk of implementing innovation and reform, and therefore should encourage and expedite acceptance and implementation of new teaching methods and philosophies within the larger system.

4. Profile of Founding Coalition

A. Describe the make-up of the group or partnership that is working to apply for a charter, including the name of the founders and their backgrounds and experiences.

The Chelmsford Alliance for Education is a coalition of community residents and businesses working toward the common goal of promoting excellence in the Chelmsford schools. The main goals of the Alliance, in the past, have been community awareness of educational issues, community support for programs within the public schools, and to help influence and support the mission and goals of the Chelmsford schools. We have embraced the establishment of a charter school to offer the families of this community another option as they seek the educational environment which best meets their children's needs and learning styles.

The founding coalition includes parents who have been actively involved in the public school system for several years, as well as educators. There are at least two parents involved who have agreed to provide some legal expertise when necessary.

Please see attached resumes for founding members' names and backgrounds.

B. Discuss how the group came together, as well as any partnership arrangements with existing schools, educational programs, businesses, non-profits or any other entities or groups.

The Chelmsford Alliance for Education is a non-profit corporation formed in 1992 by a group of parents, educators and community members interested in supporting public education in the town of Chelmsford. We have enjoyed the support of the Chelmsford School administration and have cooperated with them on a variety of programs, including:

- Shadowing program, where high school students explore career opportunities. The Alliance helped to find mentors.
- Sponsoring Dr. Willard Daggett, a nationally recognized leader in the educational reform movement, to speak to the Chelmsford community. His presentations to school staff, the School Committee and the community drew the consensus that our system needs to change to better meet the needs of our children's futures, both as citizens and employees.
- Staff development, where the Alliance funded training in areas such as Math Their Way.
- Middle school visitation, funded by the Alliance.
- Increasing the number of community readers who participated in the school librarian's reading week, where members of the general public read and share favorite books with elementary students.
- Sponsoring Dr. Michael Quigley, Dean, School of Graduate Studies, Rivier College, to address the general public in Chelmsford on issues of education reform and community collaboration.
- Writing a series of weekly articles in the summer of 1993 for the local newspaper to highlight immediate concerns in education specific to the town of Chelmsford, as well as presenting successful strategies used by school systems across the nation that have helped to bring education more in line with the needs of the future.
- Writing a series of newsletters to try to involve the community of Chelmsford in its school system.

In addition, the Alliance and the administration have had many discussions on topics relating to education in Chelmsford. Our members serve on many committees and in many leadership positions within the schools. Please see attached resumes.

C. Include any plans for further recruitment of founders or organizers of the school.

We will continue to recruit organizers and develop partnerships as the school develops. We have always been a public, grass roots organization that welcomes new members and supporters. Open meetings with the public will help facilitate further recruitment.

The founding coalition has initiated dialog with a school psychologist and experts in the field of systems dynamics.

5. School Demographics

A. Describe the area where the school will be located.

The Charter School will be located in Chelmsford, a middle-class suburban community adjacent to the city of Lowell. Chelmsford has a population of 30,000 people in 22.54 square miles. At present only 17% of households have school aged children, posing a major challenge to support of schools. While it has a large population of moderate and high income families, there exists enough of a low income population to qualify the town for Chapter 1 funds.

B. Why was this location selected? Are there other locations suitable to the needs and focus of the school?

This community was selected because the Chelmsford Alliance for Education has a basis of support in the community. We have worked with the school administration and with some members of the business community as well. Most communities would be suitable to the needs and focus of the school. This, however, is a community we know.

C. Describe any unique demographic characteristics of the student population to be served.

The town of Chelmsford is rather homogeneous. Demographics of the town's school population are as follows (1992-93 school year, grades K-8):

African Americans: 19 students

Asians: 120 students

Caucasians: 3473 students

Latin Americans: 39 students

Native Americans: 3 students

Persons with differing abilities: 31 students

Total student population: 3737 students

Therefore, efforts to make diversity apparent and acceptable to these students will need to be part of the curriculum.

The founding coalition of this charter school hopes that the successes we experience can be translated into success for other middle class communities across the commonwealth. In communities where it is widely accepted that public schools have failed, wholesale change is readily accepted. In established systems where the crisis is not as apparent, due to reputations built in the past, risk taking and experimentation are difficult to justify to the public. Middle class communities such as Chelmsford do not recognize their own need for educational reform. A successful model would help to spur other middle class communities to experiment with alternative education plans.

D. What are the school's enrollment projections for the first five years? What is the school's ultimate enrollment goal?

For the first year, we anticipate a student enrollment of 88 children. By 1997, the enrollment will be 132 children. It is possible, in the future, that the school would expand to the 5th grade, bringing the total student enrollment up to 176 students. That is anticipated to be the ultimate enrollment to continue to allow us to experiment with new, innovative approaches in education.

E. What grade levels will be served? How many students are expected in each grade or grouping?

In September, 1995, grades 6 and 7 will be served. There will be approximately 44 students at each grade level. In 1996, 8th grade would be added to the school. The possibility of adding 5th grade to the school to mirror the public middle school's configuration is not precluded.

6. Recruiting and Marketing Plan:

A. Demonstrate how you will publicize the school to attract a diverse pool of applicants.

To date, we have made the plans for a charter school public by:

- Appearing before two televised presentations to the school committee
- Presenting the charter school to the local newspaper
- Appearing on a local cable access talk show
- Holding an open public meeting on the charter school
- Preparing a collection of research and providing public access to this information through the town library, the school committee, and the superintendent's office
- Notifying parents of our intent to apply for a charter through all of the public school newsletters.

When our charter school is approved, we will continue publicizing the school further with open public meetings and in the two local newspapers, the local cable stations, the local radio stations, the local libraries and town hall. Presentations will be available to all interested groups.

We will also use any recreational activity in town, such as baseball, soccer, dance classes, church youth groups, etc., as a means of disseminating information. Chelmsford does not have a Boys' or Girls' Club or a YMCA or youth recreation groups in town.

B. What type of outreach will be made to potential students and their families?

See above. When a family indicates interest in the school, a brochure of information would be sent, followed by a personal contact from the founding coalition. We intend to recruit a diverse population of students, both in terms of ability level and socio-economic background.

C. Describe efforts to recruit students without parents to advocate on their behalf.

Teachers, principals, psychologists and guidance counselors in the public schools at grades 4 and 5 would be contacted by the charter school founding coalition in order to have the teachers identify those children in their current classrooms who might benefit from this type of instruction.

7. Admissions Policy:

A. Describe the admission methods and standards you will use to select students.

The charter school will not discriminate on the basis of race, religion, sex, color or national or ethnic origin or marital status in the family. A family's desire to be involved with the school and/or a strong recommendation from the child's current teacher, with permission from the family, is a criteria for admission. Acceptance priority will be given to Chelmsford residents and siblings of children currently enrolled.

Each student wishing to enroll in the school will have to demonstrate an ability and a desire to benefit from this unique educational approach. All students and their parents must fill out a written application form that includes a letter of recommendation from an adult teacher or leader. Parents must agree to perform some volunteer service and participate in meetings and conferences as required.

Admission to the school for September, 1995, will be started with a 2 week enrollment period. Admissions, in all cases, will be blind once the criteria outlined in the paragraph above are met. Students who meet the criteria will be assigned a number to start the admissions process. If more than 88 students enroll, a lottery will be initiated of students residing in Chelmsford. If less than 88 students enroll, the initial enrolling students will be accepted and recruitment efforts will start for remaining spaces in adjacent cities and towns. Admissions would be computed by June.

B. Describe the process and timetable to be used for admitting students, including a plan for the admission lottery for students both within and outside the district.

Blind Admissions Procedure

Students who wish to be admitted to the charter school will complete an admissions application with their parent, as outlined above. Completed applications will be collected, starting March 20th, by an admissions coordinator, a community member who does not have a child eligible for admission, who will be appointed by the core planning group. The Admissions Coordinator will check each application to see that it is complete and that the student meets the admission criteria outlined above. Each application will be assigned a random code number, marking all pieces of the application with that code number and attaching a lottery card marked with the number. The lottery cards will be color coded to distinguish sixth grade applicants from seventh grade applicants and within district and outside district. All application materials, lottery cards and number assignments will be kept confidential and in the possession of the Admission Coordinator through April 5th.

If after the initial enrollment period of March 20 to April 3, there are more qualified applicants than available slots, a lottery as required by the charter school legislation will be held on April 5th in public session. The Admissions Coordinator will remove all lottery cards from submitted applications and place them, in four boxes, one each for sixth grade within and outside district and one each for seventh grade within and outside district. Slots will be assigned first to within district students, and, if there is room, then to outside district applicants. Available slots will be assigned and posted on the master board as the numbers are drawn from the boxes in view of all attending the public session. The Admissions Coordinator, having a master list of the names matching the numbers, will post the names that go with each number selected. Any child having a sibling also applying to the school will have a star placed next to their lottery number. Any sibling will automatically receive a slot in the school if their sibling is chosen. When the available slots have been filled for each grade, the remaining cards in the box will be drawn to create a numbered waiting list for each grade for within district first, then outside district. Applicants will not be required to be in attendance at the lottery session to secure a space.

All applicants will be notified as to their status by April 10th. An initial enrollment report will then be submitted to the Department of Education by April 15th. Submitted application materials will become part of a student's record kept by the charter school. Applications received after the initial enrollment period will be assigned a space on the waiting list, or in the classes if slots are still available, in order of their receipt.

C. Explain how these policies further the mission of the school in a non-discriminatory fashion.

Admitting children of families who are willing to be involved with the school will be necessary to support the strong home-school partnership at the core of the school. All parents are expected to attend the monthly parent meetings and any scheduled conferences. In addition, each family will be required to volunteer in some way. There will be flexibility in the method and timing of the service to accommodate the busy schedules of today's families. Tasks may include helping in the classroom, demonstrating skills, secretarial support, janitorial support, etc.

8. Timetable:

Provide a detailed timetable of projected steps and dates leading to the opening of a charter school.

At this time, the Chelmsford Alliance for Education is an established non-profit corporation with 501C3 status. With this step in place, we will proceed as follows:

September 1994 - March 1995 - Core founding members will assume responsibilities for: 1.) investigating fund-raising through foundations and other private sources; 2.) investigating physical plant location options; 3.) establishing a working budget; 4.) informing the community of the establishment of a charter middle school; 5.) recruiting interested families; 6.) recruiting interested staff members; 7.) investigating partnerships; 8.) liaisioning with school committee to lay a foundation of cooperation; and 9.) researching similar successful models of middle schools using this philosophy.

Upon acceptance of our charter school application, the core founding group will act immediately to admit students. The Founding Coalition will then proceed as follows:

March to April, 1995 - Disseminate information and begin admissions procedure. Meet with the Chelmsford School Committee to discuss collaboration. Initiate staff hiring procedures. Finalize rental space agreement. Begin ordering supplies. Continue discussions with local school district. Continue to meet as a board to update status of implementation.

May to June, 1995 - Recruit students, if necessary. Finalize hiring of the staff. Develop the curriculum with staff input. (Since teacher input is vital to the success of this model and since systems dynamics needs to be fully incorporated, teachers will be developing curriculum from May through August as their staff development proceeds). Make final arrangements for staff training. Order supplies. Build out of rental space. Continue discussions with local school district. Address transportation issues. Organize the Board of Trustees as described in the governance section of this application. Continue to meet as a board to update status of implementation. Revise budget as required.

July to August, 1995 - Continue curriculum and staff development. Implement parent-teacher meetings. Initiate parental volunteer program. Final transportation needs arranged. Final set up of classroom space. Staff training held. Orientation for students.

September, 1995 - School opens.

9. Evidence of Support:

A. Try to convey as clearly as possible the scope of community backing for the proposed charter school.

The concept for this charter school came from local parents active in public education here in Chelmsford. These parents serve as PTO board members, school council members and members of curriculum review committees. An informal survey of parents in the community reveals a high level of interest and support for the concept of a learner-centered school. (See letters, 9.B.)

In addition, a number of teachers have not only voiced support but have been instrumental in providing direction and expertise in the development of this application. At this point, these teachers have chosen to remain anonymous due to the strong teacher union position against charter schools.

B. In tangible terms, such as survey or letters of support, demonstrate this community support among teachers, parents, students, community leaders and others.

See Appendix B

10. Educational Program:

A. Describe the educational program of the school, providing a detailed overview of curriculum objectives and content in the main subject areas.

It is the intent of the Chelmsford Charter School to embrace the Commonwealth's Common Core of Learning: to include a broad range of subject areas and a broad range of skill development for students. For mathematics and science, we will utilize guidelines such as PALMS and NCTM standards.

The charter school educational program is a comprehensive curriculum. It will include the following core subject areas:

Mathematics
Language Arts
Physical Education
Foreign Language (grade 8)

The following subject areas will be taught in interdisciplinary units:

Science
Social Studies
Fine Arts
Health

The curriculum content within general subject areas will mirror the public schools in order to make the transition back into the public schools in grade 9 go as smoothly as possible. It will be the focus on systems dynamics and the delivery method of the charter school which will differ.

Systems dynamics will offer the students a whole brain visual aspect to facts, patterns and the bigger picture of problems. Specific units that involve research, field trips, etc. can be created. Mapping and models using software such as STELLA, designed by High Performance, can help students predict the outcomes of the models they create to better define a problem. By seeing the outcomes of the models they create, students can continuously refine and manipulate their model and its variables to predict other outcomes. "...as they build or manipulate computer models, they are also building mental models, mental constructs and connections, and this is the ultimate goal of good teaching. For the first time they can see and think about real-life systems and manipulate them to see consequences in real time or compressed time. Students can formulate hypotheses about previously incomprehensible concepts and test the experimental model in a matter of minutes." ("Learner-directed system education: a successful example, Frank Draper and Mark Swanson, 1990).

Math

Our core math curriculum will be based on the NCTM Standards. Concurrent with the math program, students will use and apply mathematics as part of the interdisciplinary units. Of particular importance is an in-depth understanding of graphs.

The core curriculum will provide a strong pre-algebra program which will assure a smooth transition from arithmetic to a full year of algebra for all eighth grade students. The children will be able to:

- Problem solve and think critically, which is the process of applying previously acquired knowledge to new and unfamiliar situations using a variety of mathematical techniques.
- Communicate - Mathematical ideas will be expressed by writing, speaking, making models, drawing diagrams and preparing graphs.
- Compute - Use a variety of computational techniques as appropriate.
- Measure - Use concrete experiences to learn to measure.
- Use numbers and number systems, with an emphasis on why numbers occur and why processes work.
- Understand and utilize principles of Geometry.
- Use probability and statistics - Collect and analyze data of interest to the students.
- Understand and utilize algebraic concepts.

Language Arts

The goal is to enhance growth of communication skills in an environment that encourages students to read, write, listen and speak. The teachers will use a process writing approach as a foundation for the writing program. The children will also learn:

- Mechanical skills
- Spelling
- Elements of writing
- Grammar
- Oral language skills

The reading program will be literature-based and will provide the students with a wide range of reading materials. The students will learn to:

- read critically
- read for response
- read for information
- read comparatively
- -read technical materials

Interdisciplinary Study and Systems Dynamics

Students will research topics that are of central importance in science, social studies and the arts utilizing systems dynamics. Some topics will be chosen because of their central importance to the discipline; others will be chosen because of their relevancy to students.

Systems dynamics gives students a "more effective way of interpreting the world around them. They should gain a greater and well-founded confidence for managing their lives and the situations they encounter. The objectives of a system dynamics education might be grouped under three headings:

1. Develop personal skills
2. Shaping an outlook and personality to fit the 21st century
3. Understanding the nature of systems in which we work and live."

("Learning through Systems Dynamics as Preparation for the 21st Century" by Jay Forrester).

Two of the key aspects of systems dynamics that are of interest to the charter school are: 1. it looks for interconnecting structures to give meaning to the parts; 2. it helps to "provide the kind of foundation that gives a student mobility to shift with changing demands and opportunities.....Transferability of structure and behavior should create a bridge between science and the humanities. Feedback-loop structures are common to both. An understanding of systems creates a common language. Science, economics, and human behavior rest on the same kinds of dynamic structures." (ibid, see above).

A systems viewpoint is "...when you are standing back far enough - in both space and time - to be able to see the underlying web of ongoing, reciprocal relationships which are cycling to produce the patterns of behavior that a system is exhibiting. You're employing a systems perspective when you can see the forest for the trees." ("Systems Thinking: Four Key Questions" by Barry Richmond, High Performance Systems, Inc. , 1991).

Students at the charter school will be able to:

- understand how systems dynamics works.
- effectively apply knowledge to real world situations.
- clearly articulate the topic of study.
- research topics using multiple researching techniques (ex. books, library, computer, etc.)
- gather quantitative data relating to subject matter.
- develop critical thinking skills.
- utilize primary sources as needed.
- understand and create causal loop diagrams (which forces one to clarify one's thoughts and assumptions).
- build, revise and refine a computer model to fit the reality of what they are studying.
- manipulate models to solve problems.
- Communicate findings in a variety of ways:
 - oral presentation
 - written presentation
 - dramatic presentation
 - visual presentation
 - technological presentation

Students will know they have learned their subject matter and will be able to present it in a knowledgeable manner to others. Self esteem will be enhanced by the students' feelings of competence.

Example Topic

Freeman Lake

- Articulate problem - I go swimming, and it's gross. There are dead fish in the water and it's slimy. Why?
- Research into the history of Freeman Lake
- Research water chemistry.
- Perform physical measurements on the lake (ex. temperature of lake at different locations; sampling of number of fish, dead and alive; volume of lake; water flow in and out of lake; chemical analysis of water, etc.).
- Find and speak to primary sources to interpret data.
- Set up causal loop diagram.
- Revise causal loop diagram.
- Build computer model of the problem.
- Feed data into model.
- Check model against reality and then revise, revise, revise!
- Use model to stop the fish from dying and the water from being slimy.
- Present findings to the class.

B. What teaching methods will be used? How will this pedagogy enhance student learning?

The central model for the charter school is student-centered learning. Learning will be student-driven, with the teacher as facilitator, not necessarily as the authority on a given topic. By focusing on "a common teachable core of broadly applicable concepts, we can now visualize an integrated, systemic, educational process that is more efficient, more appropriate to a world of increasing complexity and more supportive of unity in life." "Systems thinking can not be acquired as a spectator sport...Hands-on involvement is essential to internalizing the ideas and establishing them in one's own mental models." Forrester, Jay, System Dynamics and Learner-Centered-Learning in Kindergarten through 12th Grade Education, 1992).

By working this way, students do not merely memorize material for a test but internalize and use the information to solve real problems.

C. Describe the school calendar and hours of operation of the school.

The school calendar will follow the Chelmsford Public School calendar, starting in early September and going through to the end of June. There will be 180 days in the school year. The hours of operation of the school will depend, to some degree, on the collaboration of the Chelmsford Public School system. We would like to coordinate transportation with them as much as possible. Therefore, school would start at the same time as the system's high school or middle school and end at the same time on Mondays and Fridays. Since late buses are available Tuesday through Thursday, school would run longer on those days. The high school in Chelmsford starts at 7:25 a.m. and ends at 1:50 p.m.; the middle schools start at 8:20 a.m. and end at 2:20 p.m. The late buses pick children up at about 3:35 p.m. Our hours would run accordingly.

The hours of operation are tentatively scheduled for 7:25 a.m. to 1:50 p.m. on Mondays and Fridays and 7:25 a.m. to 3:30 p.m. Tuesdays through Thursdays. This is to accommodate transportation available through the Chelmsford Public Schools.

11. Student Performance

A. Describe your proposed plan to assess student performance.

MEAP testing in grade 8 and other standardized testing will be implemented (as chosen by staff members) to objectively measure student performance within the larger student population in the Commonwealth. Students will be expected to meet or exceed all state performance standards in all academic areas.

Assessment will be a method to improve the performance of the students, not just measure it. It is also a means of improving instruction. Emphasis will be placed on expecting quality work from all students.

Expectations for each and every assignment will be clearly defined and articulated to the students prior to the assessment task. Assessment will be an integral part of instruction and will involve a wide variety of assessment tasks.

The assessment tasks will be based on rubrics along with narrative comments. A portfolio will be developed that encompasses a variety of tasks, for example long term group projects, traditional tasks, an interdisciplinary application, an oral presentation, self assessment, etc.

The assessments will be shared with the parents periodically throughout the year.

A concise, permanent, objective record of student performance will be developed by the Board of Directors and the staff and will be available for completion of official student records.

An assessment test designed by both staff from the charter school and the public schools will aid in placement of charter school students upon return to the public high school. In this way, we will ensure that students are prepared to easily transition into high school across all ability levels, including advanced placement.

B. What remediation will be available for underperforming students?

By providing underperforming students with narrative assessments and examples of quality work, they will be able to progress to the next level of achievement.

Individualized reteaching loops will be provided until quality work is produced. The parental component of the school will ensure timely communication with the home in order to provide a coordinated remedial program.

Mentors will be responsible for helping to find tutors for underperforming students. These tutors could be staff members, peers or parent or community volunteers. Specific areas requiring remediation will be communicated to the tutors from the teaching staff.

C. How will student development towards the school's stated learning objectives be measured?

The school's stated learning objectives will be measured in a variety of ways:

- looking at student portfolios from a systems perspective.
- regular, informal observation of student behavior in every day settings.
- inspection of the physical plant.
- keeping track of discipline that needs to be referred out of the "family/peer" setting.
- questionnaires for students, parents and teachers.
- self evaluation.
- checking on absenteeism.
- continual monitoring by an outside observer.

12. Accountability:

A. What methods of self-assessment or evaluation will be used to ensure that the school is meeting its stated mission and objectives?

Using our stated goals and objectives, the evaluation process will be on-going. The Board of Trustees and the school administrator will work together to set up specific criteria for each half year. Parents, students and staff will have opportunities for formal and informal feedback. Vehicles will include written surveys, discussion at parent meetings, "peer family meetings" at the beginning of the school day and a constant open door policy of the administrator. On an annual basis, the school administrator will work with an independent consultant to evaluate the program and develop action plans for needed improvements. This evaluation will provide the opportunity for staff, parent and student input (see #11 above for additional information).

B. How will teachers and administrators be evaluated? Describe your standards for teacher and staff performance.

The evaluation procedure will have several components:

- *Teacher and administrator goal-setting for themselves every 5 months (see goals and objectives). This will include both professional personal goals and goals within the framework of the charter school's objectives.

- *Weekly informal meetings between teachers and the administrator. This time will be utilized for discussing concerns, sharing curriculum ideas and giving support.

- *Peer observation for the purposes of education and improvement. Observations will include: teacher's communication with the students; student behavior; content of lesson; classroom dynamics. These observations will be shared with the observed teacher and reflected in further goal-setting sessions. It is expected that these goals would be used in a constructive manner to further the school's objectives and the teachers' professional growth.

- *Parents and students are encouraged to immediately address concerns about a staff member with that staff member first. Unresolved concerns should be brought to the attention of the administrator. Should the concern involve the administrator, it should be brought to the Board of Trustees.

- *Parents and students will complete a formal evaluation form twice a year.

- *The administrator will review the goals and collected information with each staff member to enable constant improvement. The Board of Trustees will perform this role with the administrator.

C. How do you plan to hold your school accountable to the public and parents of the children in attendance at your school?

The charter school will have an on-going dialogue with parents through the monthly school meetings. These meetings will showcase completed student work from the prior month and will highlight the topics to be addressed in the coming month. Additional communication from individual teachers to the parents will be encouraged.

Because parents will volunteer in some manner for this school, there will be more awareness on the part of the parents as to what goes on in the school. In addition, with prior approval of the staff to ensure that no disruptions will occur, the public can visit the school and observe the program.

In order to keep the public apprised of the charter school's progress, the Board of Trustees will issue a report twice a year. This report will be made available in the local public library and at town hall. This report will be presented at the public school committee's meeting. These meetings are televised and covered by other local press.

D. Discuss your plan for regular review of school budgets and financial records.

All financial records will be computerized. These will be reviewed regularly at Board of Trustee meetings to keep the charter school fiscally responsible. In addition, an annual audit will be performed.

E. Describe you system for maintaining school records and disseminating information required under public school law, including the annual report, as set forth in M.G.L. c.71,s89.

Student Records

1. Parents of students entering the charter school must request that their child's sending school transfer his/her records to the charter school. These records along with any additions during the student's years at the charter school will be transferred, upon the written request of the parent, to the student's receiving school when the student leaves the charter school.

2. Parents will have the right to examine all records that are maintained by the charter school on their child. All records will be kept on the premises of the charter school. stored in the office area with provisions made to ensure privacy.

3. Records will include a portfolio of the student's work to reflect classroom progress, evaluations by teachers or others, student self-assessment information, discipline records and the results of any testing.

4. Any parent has the right to add materials or statements to the student record of their child. Any parent may request that the Administrator delete material from their child's record. The parent may appeal a refusal to delete information to the Board of Trustees of the charter school.

5. A log of access will be kept for each student's record. This log will include the date of access and the name and position of the person who accesses the record.

6. These rights shall be the rights of the student upon reaching 14 years of age.

7. At least once each year, the charter school will notify, in writing, all parents and students of any standardized test or research studies to be conducted during the year and of a summary of these rights and regulations concerning student records. Copies of the complete regulations will be made available upon request.

8. The charter school will follow the regulations for access by third parties as stated in 603CR 23.07:section \$.

Annual Report

The Board of Trustees will prepare an Annual Report by August 1st each year for the preceding year. This Annual Report will include:

1. Discussion of the progress made toward achievement of the goals set forth in the charter.
2. A financial statement, listing revenue and expenditures by category.
3. A listing of the charter school's Board of Trustees and staff.
4. Discussion of key objectives for the year to follow.

This Annual Report will be sent to the Secretary of Education and will be available to each parent or guardian of the charter school's enrolled students. In addition, it will be made available to parents or guardians contemplating enrollment. Additional copies will be sent to the Chelmsford Public School Superintendent and School Committee and the Chelmsford Public Library and Town Hall.

13. Human Resource Information:

A. Describe the standards to be used in the hiring process, including teacher certification requirements or any other professional credentials.

All classroom teachers will have Massachusetts teacher certification or will have had experience teaching successfully at these grade levels for a minimum of 3 years. They will also possess experience in an integrated, developmental approach to education. The teachers and administrator must be willing to be trained, prior to the opening of school, in systems dynamics and the mentoring, "peer family" approach, as well as in assisting in curriculum development. An interviewing committee from the Board of Trustees (the first year, it will be the founding coalition) will interview each candidate, review their documentation and recommendations and observe them in action.

All physical education instructors will show demonstrated expertise in the area hired for. Massachusetts teaching certification will not be required. These instructors will also be interviewed and observed.

B. What is the targeted staff size and teacher/student ratio?

There will be four teachers, one administrator/teacher and two aides for the 88 students in the first year. An administrative assistant will also be on site. The ratio of students to teachers will be no more than 22 to 1. There will also be an aide per grade level. We will work to maintain this ratio as the school grows.

C. What professional development opportunities will be available to teachers and other staff?

All full-time staff of this charter school will be fully trained in systems dynamics and computer models of system dynamics. Staff will be introduced to the concept in the summer and supported in its implementation throughout the school year.

In addition, a "peer family" mentoring program will be instituted in the school, with extensive staff training and support prior to implementation. Additional staff development monies have been put aside for areas that are identified through goal-setting sessions. Approval by the administrator is required prior to participation.

D. Describe your human resource policies governing: salaries, contracts, hiring and dismissal, benefit packages.

All staff will be hired after a thorough review. The administrator will be hired first. The process will include filling out an application, going through at least two rounds of interviews by a panel of founding members and an on-site visit for the purposes of observation.

Teachers will be hired in a similar process that includes members of the Board of Trustees (founding members, the first year) and the administrator.

For contracts and dismissal, as well as job descriptions, please see Appendix D. Salaries will be arranged as follows (see budget proposal, also): The administrator will be paid \$50,000 the first year; the more experienced teaching staff will receive a salary of \$43,000 per year; the less experienced staff would receive \$28,000 per year; special education consultants would be paid \$5000 per year; physical education staff would be paid at an hourly rate (the total phys ed teaching budget is \$5000 the first year); the psychologist would be paid \$5000 the first year; classroom aides working part time would receive \$8000 per year; the administrative assistant would receive \$24,000 annually the first year). The benefit package would include health insurance, life insurance, sick days, personal days and professional development.

14. School Governance:

A. Describe the internal form of management to be implemented at your school, including any plans to contract with an outside group to manage the school.

There will be one administrator/teacher who will be hired to manage the day-to-day operation of this facility and program. He/She will be responsible for all record keeping and reporting, meeting established charter school goals and objectives, and ensuring all state and local safety and health guidelines are met.

The administrator will be responsible for disciplinary matters. The board of trustees will be responsible for hiring and firing of future staff, curriculum development and expansion, evaluation of school program, and liaison with outside evaluator.

Bookkeeping will be performed by the administrative assistant. Payroll functions will be contracted to an outside vendor. It will be the administrator's job to interface with these contractors.

B. How will the Board of Trustees be chosen?

The founding coalition will choose the first Board of Trustees. This Board will consist of nine people:

- 3 school staff, one of whom will be the administrator
- 4 parents
- 1 community member
- 1 consultant

For staff and parents, elections will be held among peer groups for the board positions. Terms will be two years with reelection possible.

The two remaining positions will be open to interested persons, with the final selection decided by the standing Board of Trustees. (Founding Coalition the first year).

C. Describe the roles and responsibilities of the Board.

The Board of Trustees will provide consultation to the administrator.

The Board of Trustees will provide support in fund raising, community interaction, finances and other areas requested by the administrator. Subcommittees may be formed and chaired by different members of the Board of Trustees to aid in the governance of this school. The board of trustees will be responsible for hiring and firing of future staff, curriculum development and expansion, evaluation of school program, and liaison with outside evaluators.

The Board of Trustees will involve teachers in the development of the budget and the curriculum in accordance with M.G.L. c.71, s.89 and will comply with the open meeting law after the effective starting date of the charter.

D. Describe the relationship of the board to teachers and administrators.

See A, B and C above.

decision making matters.

With the set up of the Board of Trustees, students and parents have a viable means of involvement in school decision making. During two of the scheduled monthly evening parent-teacher meetings, issues pertinent to the school community will be discussed. All parents and students will participate in the evaluation processes. In addition, the administrator will have an open door policy to ensure on-going input throughout the school year.

Student concerns and input should be brought up at Student Council meetings. The students, along with a faculty advisor, will develop this organization themselves.

15. School Community

A. What type of community environment do you hope to foster at your school?

Because the middle school years are a time of critical change in a person's life, a consistent environment for positive social, emotional and physical development is essential. It is through this supportive environment that the developmental changes occurring at this time can be made the most positive. Opportunities for mentoring will be established between staff and students to develop important personal relationships as well as opportunities for learning.

B. Describe the nature and extent of parent involvement in the life of the school.

A key element to the success of this charter school will be the home-school partnership. On-going communication between these two aspects of each student's life will help to expand the community beyond the school. Linkage between home and school will take many forms. Parent participation will be required on some level. Monthly meetings between staff and parents will be scheduled to discuss not only school business but pertinent educational and parental issues as well. In addition, each parent will volunteer to perform several hours of service each year, based on his or her availability and talents. These jobs could include: housekeeping, xeroxing, office tasks, guest lecturing, tutoring, sponsoring an apprenticeship for a student in the workplace, providing enrichment materials for classroom study, etc. A listing of possible jobs will be prepared and posted by the administrator for parents to choose from for their participation requirement. Parents are also welcome to propose other jobs to the administrator that meets the school's needs. A parent coordinator will supervise parent participation as their contribution.

C. Describe the relationship of your school to the surrounding community and vice versa.

Interaction with the community of greater Chelmsford, through business partnerships and community involvement, will give the students a sense of belonging to the community in which they live as well as offering the greater community a sense that they have a stake in the local school population. Many of the learning units that the students will study will be based on community issues. Student reports on these issues will be sent to the town hall and the library, and will be summarized for the local press. This may provide unique perspectives on community issues and provide some creative solutions.

In addition, the students will utilize the community's resources in a variety of ways. Field trips to local businesses and town offices will be integrated into the curriculum. The town library will be a major resource and all students will be instructed in the use of inter-library technology.

16. Replicability and District Relations:

A. How will your charter school offer replicable educational models to the schools in the surrounding districts?

It is our intention to enter into a collaborative relationship with the Chelmsford Public School District. Dialogue to date has resulted in an invitation from the school committee for further discussions upon receipt of the charter. We will invite interested staff and board members from the public schools to observe our classes in order to see systems dynamics in action. End product reports on all learning units will also be available for review.

Based on the fact that teachers, by charter school law, may take a two-year leave of absence from their school district, it is our hope that teachers hired from Chelmsford will return to their district, and bring with them the experience and training they received at the charter school. This will expand this educational model into Chelmsford public school classrooms in a reasonably short time frame.

B. If applicable, provide any specific programs to be provided by the charter school which would directly benefit the district. Besides the informal interactions mentioned in A, periodic educational presentations for the charter school will be open to the rest of the Chelmsford community, as space allows. If interest in a given topic creates a large demand, a larger space will be requested from the Chelmsford Public Schools.

C. What efforts, if any, have you made to build rapport with the district from which your charter school would draw students? Several efforts have been initiated by the founding charter coalition. These include meeting personally with each school committee member and the superintendent, a publicly televised presentation to the school committee as a whole and a community meeting to introduce the charter to all Chelmsford residents. It is our hope to collaborate with the school committee to coordinate transportation schedules, school calendars, use of building space and flow of information between the two systems.

17. Building Options:

A. Describe your present options for a school building.

We are investigating several options for building space:

- Space within an existing Chelmsford public school building would be the most desirable location. This is currently being discussed with the school committee.
- The University of Massachusetts at Lowell's College of Education is located in North Chelmsford. We are investigating the possibility of space there.
- Commercial space in Chelmsford is readily available. Several landlords have been approached and have expressed interest in working with this group.

B. Demonstrate how these sites would be suitable facilities for the proposed school, including any plans to renovate and bring the facility to compliance with all applicable school building codes.

- Space in the Chelmsford Public Schools is already being used as classrooms in a school building. No renovation would be needed.
- Minor renovations to accommodate younger students would be needed at the University of Massachusetts at Lowell..
- A number of landlords expressed an interest in housing this charter school. Renovations and buildouts would be performed by the landlord and incorporated into the monthly rental bill.

We will meet with the building inspector to bring the chosen facility into compliance.

C. Discuss any progress or future plans for acquisition of a school building.

Currently, there are no plans for acquiring a school building.

D. Describe financing plans, if any.

Not applicable.

18. Code of conduct:

A. Discuss any rules or guidelines governing student behavior.

The safety and welfare of the students in the charter school is the responsibility of the staff. The home-school partnership inherent in the charter school will encourage excellent communication between teachers and parents. Any behavior problems not capable of being addressed in the school family groups will be addressed between the student, his or her parents, his or her teacher(s) and the administrator. Corrective actions will be determined by all present at this meeting.

Guidelines suggested are:

- All people involved in the charter school will treat each other with respect and courtesy.
- Destruction of property of any kind (i.e. books, supplies, buildings, etc.) is not allowed.
- Bullying, fighting, rough housing, etc. are not allowed.
- No weapons of any kind are allowed on school grounds. Possession of any weapons will result in suspension and notification of the police.
- Drugs, alcohol and cigarettes are not allowed on school grounds. Possession of any of these will result in suspension and notification of the police.
- People attend this school to get an education. Constant disruption of classroom activities will not be tolerated.
- No one may leave school grounds during school hours without permission from the administrator or his/her assistant.

The students will help to develop student behavior guidelines as well.

These rules can be amended by the Board of Trustees.

The code of conduct will comply with M.G.L. c.71, s.37H.

B. Describe your school's policies regarding student expulsion and suspension.

The Charter School will first try to solve student behavior problems within the family groups that meet each morning. If a resolution can not be achieved, the student will be referred to the administrator for disciplinary action. Logical consequence discipline will be the basis of these actions.

Students will be suspended for possession of a weapon, drugs or alcohol on school grounds.

Any of the conduct guidelines that require a parent/teacher/student conference more than once will result in suspension.

Any student convicted of a felony will be expelled from school.

Any student who has been suspended three times in the school year will be expelled.

19. Special Needs and Bilingual Students:

A. Describe how your school will accommodate special needs students.

It is our intention to be inclusionary, not exclusionary. A special needs consultant would aid the school staff in accommodating children's special needs. The small groups and small class sizes will allow for more individualized attention for each child. Because of the developmentally appropriate approach that is so central to this charter school, it is anticipated that all children will find greater success at their own level. All of this will be monitored by the Special Needs consultant, who will assure compliance with 71A and 71B.

B. Describe how your school will accommodate bilingual students.

There are few children in this town who use English as a second language. However, if a child has needs in this area, they will be accommodated through arrangements made with tutors through the special education consultant. It is our intention to mainstream bilingual students as quickly as possible. We will continue to support them in the classroom, according to their individual needs.

20. Funding:

A. Devise a start-up budget covering the planning and capital expenses before school opening.

See Appendix E.

B. Do you plan to conduct any fund-raising efforts to generate capital or to supplement the per pupil allocations? If so, explain.

The start-up costs of this charter school are within the per pupil allocations from the Chelmsford public schools. Grant monies and foundations are currently being solicited to fund additional wish lists on start-up costs. Although total student enrollment is small, the school is designed with realistic student/teacher ratios, which are reflected in the budget. After start-up and expansion into the eighth grade, the per pupil expenditure comes closer to meeting the needs of the charter school. Substantial monies are being budgeted for staff development. Although funding is tight for the first year, the budget does include a 10% overage for unforeseen circumstances in each year, years 1 through 5. Between this and fund raising, the founding coalition is confident that the budget is realistic and viable.

C. Using the attached template, devise a 5-year budget covering all projected sources of revenue, both public and private, and planned expenditures.

See Appendix E.

21. Transportation:

A. Discuss plans for transporting students within the local district to and from school. What arrangements, if any, will be made with the local school committee?

If the charter school can be located in an existing public school building, we will start and end the school day to coincide with existing school buses. The public high school runs from 7:25 am to 1:50 pm for its regular school hours. The middle schools run from 8:20 am to 2:25 pm. Tuesday through Thursday, late buses are offered so that the students can participate in after-school activities. The charter school would like to work with the school department to minimize the cost (or, in fact, eliminate it) of transporting students. Therefore, school would be dismissed earlier on Mondays and Fridays, while late buses would be used the rest of the week. The local school committee has been presented with this information.

If the school is located at the local university or at some commercial space in town, the students from the charter school could start their day with the high school students, gather at the high school, and buses destined to pick up other middle school students in the part of town where the charter school is located could drop those children off prior to starting their next run of the day. This would help to minimize transportation costs. The end of the school day would not be as easy to accommodate. Two buses would be required to transport the children home.

B. How will students who live outside the district be transported? At this time, based on the size of the school and the community support it has elicited, we do not anticipate out-of-district transportation needs. However, if there are students who live outside the district, each situation would have to be addressed individually. Locating the charter school along a local public transportation route could offer one alternative.

C. If you plan to implement an extended day or extended year program which requires transportation beyond what the district provides, what arrangements will be made to transport students? We have addressed the extended day program in A. There is not a current plan for an extended year.

APPENDIX "A"

RESUMES

BRIAN M. HAGOPIAN
1 Boyds Lane
Chelmsford, MA
508-256-4701

PROFESSIONAL EXPERIENCE

FLUID SOLUTIONS, INC. Chelmsford, MA 1989-present
Fluid Solutions designs, engineers, installs, services and maintains water purification and wastewater treatment systems for industry.

VICE PRESIDENT/SALES ENGINEER

- Started corporation; wrote business plan; obtained financing, set up purchasing and billing systems, established customer base.
- Paid off first round of debt in 5 years.
- Built business to over \$1 million of sales in 5 years.
- Established and implemented a philosophy of service and expertise to customers to obtain broad, long-term business relationships.
- Penetrated new market niches by establishing rapport with architects, consultants, contractors, etc.
- Perform fee paid consulting to solve complex wastewater treatment applications on a nationwide level.

ARBEN ENTERPRISES, INC. Chelmsford, MA 1986-present
Arben manufactures specialty water filters for military applications.

VICE PRESIDENT

- Conceived and developed the product line for a specific enduser.
- Designed all custom parts and method of manufacture of the filters.
- Manufacture filters.
- Update and maintain quality records: requires familiarity with Mil Specs.
- Interface with government representative to obtain direct government approval of Arben.

ACCOMPLISHMENTS

- Produced sales of \$32,000 the first year, \$61,000 the second year, and \$77,000 the third year with profit margins in excess of 40%.
- Paid off capitilization of Arben in its first year of business.

INDUSTRIAL FILTERS AND EQUIPMENT CORP. AND Burlington, MA 1/82-3/89
NORTH EAST WATER SERVICE DIVISION

SALES/APPLICATION ENGINEER

- Sold and engineered fluid filtration and water purification systems.
- Engineered custom systems and integrate product lines for complete turnkey systems installations.
- Determined all pricing to customers in the territory to ensure maximum profitability in fully commissioned sales territory.
- Broadened customer base in territory by targeting specific end-user market segments.
- Coordinated with service department to ensure committments are met.
- Implemented a philosophy of service and expertise to customers to obtain long-term business relationships.

ACCOMPLISHMENTS

- Doubled annual sales volume in territory for three consecutive years.
- Increased territory sales over ten fold in a six year period.
- Annual sales were over \$900,000 in last year.
- Responsible for 25% of company sales (1 of 9 salesmen) in last year.
- Developed several unique products for highly specific end uses.
- Introduced the "service contract" concept to the company and clients.
- Performed fee paid consulting services.
- Successfully penetrated biotechnology market with new products.
- Installed the company's first three double pass reverse osmosis system in the field.

High Voltage Engineering

Burlington, MA

10/79-12/81

SALES ENGINEER

- Developed and penetrated new markets while building existing base for \$3.5 million instrument manufacturer.
- Determined technical feasibility of new applications.
- Trained and managed one professional.

General Electric Co.:Plastics Division

Pittsfield, MA

10/78-10/79

TECHNICAL MARKETING SPECIALIST

- Performed customer service function for Structural Foam and Valox technical marketing groups.
- Developed two proprietary processes for smooth surface structural foam molding.
- Orchestrated a three-day 35 customer seminar.
- Developed a slide presentation relating processing conditions to physical properties of structural foam parts.

Collaborative Research

Waltham, MA

7/77-8/78

- Performed DNA research funded by the National Science Foundation.

EDUCATION

Colgate University

Hamilton, NY

B.A. Chemistry, 1977

Seminars: Time Management Skills; Consultative Selling; Effective Writing; Dale Carnegie Course in Effective Public Speaking; General Electric Sales Seminar; Kepner Tregoe Problem Solving.

Professional Affiliations:

- Member Water Quality Association
- Member American Filtration Society
- Member American Society of Plumbing Engineers
- Member International Society of Pharmaceutical Engineers.

PERSONAL

1989-present- Chelmsford Little League Baseball Coach

1989-1990 and 1992- Cub Scout Pinewood Derby Chairman

1990-present- Chelmsford Youth Soccer League Assistant Coach

1993-present- Member Chelmsford Alliance for Education

1993-present- Member of the Chelmsford High School Improvement Council.

1994-present- Cub Scout Co-Leader (Tiger Cubs)

NINA S. LEWIN
1 Boyds Lane
Chelmsford, MA 01824
508-256-4701

EDUCATION

Colgate University Hamilton, NY B.A. Chemistry, 1977
Magna Cum Laude, with honors; GPA 3.76/4.0; Phi Beta Kappa

PROFESSIONAL EXPERIENCE

Fluid Solutions, Inc. Chelmsford, MA 1989-present
Fluid Solutions designs, engineers, installs, services and maintains
water purification systems for industry.

PRESIDENT

- Started corporation from scratch: wrote business plan, obtained financing, set up purchasing system, established accounting procedures.
- Paid off first round of debt in 5 years.
- Built business to over \$1 million in sales in 5 years..
- Established and implemented a philosophy of service and expertise to customers to obtain broad, long-term business relationships.
- Ensure all customers' invoices are paid in a timely fashion: have written off less than \$1000 in bad debts in 5 years.
- Manage benefits for the corporation: selected and set up health plan, established pension plan for employees, established cafeteria plan for employees.
- Update necessary software to run accounting system more efficiently as the company grows.
- Have impeccable credit references from all vendors.
- Sole responsibility for all accounting functions within the company.

Arben Enterprises Chelmsford, MA 1986-present
Arben manufactures specialty water filters for military applications.

PRESIDENT

- Set up company books and provide all bookkeeping services.
- Establish cost accounting procedures.
- Purchase all supplies.
- Manufacture filters.
- Liaison with lawyers and accountants.
- Wrote quality control brochure.
- Establish faster, more reliable methods of manufacturing.

ACCOMPLISHMENTS

- Produced sales of \$32,000 the first year and \$61,000 the second year, with profit margins in excess of 40%.
- Paid off capitalization of Arben in its first year of business.

SALES DIRECTOR

- Sold vacuum forming and fabricating of custom plastic parts.
- Established weekly, monthly and yearly sales goals for the company.
- Interfaced with customers at engineering, quality control and purchasing levels.
- Coordinated with production, vendors and customers to ensure that all commitments were met.
- Quoted all jobs: required the ability to read prints and a complete understanding of how a part would be made.
- Qualified and liaised with vendors (painters, material suppliers)
- Established and implemented a philosophy of service and expertise to customers to obtain broad, long-term business relationships.
- Provided employee training and maintained records on hazardous materials used in the workplace, per Massachusetts law.

ACCOMPLISHMENTS

- Turned an unprofitable, untrusted supplier into a profitable company in 2 years, with a reputation for outstanding quality, service and on-time delivery.
- Doubled sales volume in 2 years.
- Added breadth to the customer base by targeting specific market segments, end-users, etc.
- Added depth to the customer base by servicing existing customers with engineering reviews, quick turn-arounds on prototype projects, material selection aid and providing on-time delivery.
- Initiated and maintained the process to establish Trans Form as a UL-Recognized Fabricator of plastic parts.
- Wrote the Quality Control Manual.
- Wrote and directed the production of a company brochure.

Van/Grace Associates

Marlboro, MA

11/80-12/81

TECHNICAL PERSONNEL CONSULTANT

- Recruited and placed salaried technical, sales and management personnel for the chemical process industries.

Chomerics, Inc.

Woburn, MA

11/79-11/80

Chomerics manufactures electrically and thermally conductive adhesives, caulks, coatings and gaskets for the electronics industry.

APPLICATIONS LABORATORY MANAGER

- Set up and managed the laboratory which responded to the short-term technical needs of sales and marketing.
- Liaised between R & D and Sales.
- Coordinated with Quality Control to establish new test methods: required familiarity with Mil Specs and ASTM methods.
- Selected proper materials for specific end-use applications.
- Presented seminars.
- Aided manufacturing with scale-ups.

ACCOMPLISHMENTS

- Developed a test program for a personal computer manufacturer which resulted in the largest coating sale to that date.
- Identified the cause of failure of over \$1/2 MM worth of silver-filled epoxy adhesive, thereby preventing its return.
- Designed and purchased all equipment for doubling the size of the Research Labs.

APPLICATIONS DEVELOPMENT SPECIALIST

- Performed customer service function for Lexan thermoplastic resin.
- Provided technical assistance regarding the decoration and assembly of plastic parts.
- Performed failure analyses.

ACCOMPLISHMENTS

- Developed and presented a slide presentation on plastic secondary operations.
- Wrote three brochures.
- Published an article in Design News: "Choosing RFI Shielding for Thermoplastic Resins," March 10, 1980, pg. 211-216.
- Properly identified the cause of breakage of parts worth over \$1MM in sales.

PERSONAL

Volunteer Work

- 1993-present-President, Chelmsford Alliance for Education, a non-profit organization dedicated to excellence in public education in Chelmsford.
- 1993-present-Member Westlands School Improvement Council - elected by PTO.
- 1992-present-Enrichment Coordinator for town-wide PTO in Chelmsford - successfully brought a multi-cultural program involving the schools and the community to Chelmsford; participated in town-wide cultural event sponsored by the Cultural Council by coordinating with the schools.
- 1993-present-Town Meeting Representative for precinct 1.
- 1993-present-Odyssey of the Mind Coach - Division I Team.
- 1991-1993-President, Chelmsford Town Wide PTO - brought after-school program to all elementary schools in Chelmsford, negotiated picture contracts for the district, coordinated joint meetings of all PTO's in town.
- 1989-1992-Enrichment Coordinator for Westlands School - successfully tied enrichment programs to the curriculum at each grade level; established yearly author program; wrote over \$10,000 in successful grants to off-set the cost of enrichment programs in the school.
- 1990-1992-Cub Scout Den Mother

ARLENE R. PARQUETTE
20 SYLVAN AVE
CHELMSFORD, MA 01824
(508) 250 - 8075

PROFESSIONAL EXPERIENCE

Technical Sales Representative (April 1994 to Present)

BioStar, Inc. - Boulder, CO

Sales representative for diagnostics company with leading edge technology, currently applied to testing for the clinical microbiology laboratory. Territory responsibilities include major hospitals, health maintenance organizations, and reference labs. Also responsible for some supervision and training of representatives in the New England area.

Near Patient Testing Consultant (January 1991 to March 1994)

Ciba Corning Diagnostics - Medfield, MA

Sales representative for large diagnostics corporation, as part of the Near Patient Testing Division. Managed sales of diagnostic laboratory instruments designed for "point of care" testing. Received President's Sales Club Award for 1991, 1992, and 1993. In 1992, I was named to the President's Circle, an award given to only one representative from each division for high sales performance, outstanding professional conduct and customer satisfaction as well as demonstrated leadership. I was also the top ranked sales representative for 1993. Territory responsibilities included major medical centers in the New England area such as Massachusetts General Hospital, University of Massachusetts Medical Center and Bay State Medical Center, as well as ancillary accounts such as physician office labs and home health care agencies. As a result of my exceptional product knowledge and selling skills, I was often called upon to assist in training of other representatives both in individual as well as group settings.

Medical Sales Representative (December 1984 - January 1988)

Mead Johnson Pharmaceutical Division of Bristol-Myers Squibb - Boston District

Sales representative for major pharmaceutical company, marketing several major prescription products to physicians, pharmacists, and hospitals. Completed comprehensive training in sales presentation, and successfully increased market shares for all prime products within my territory. Gained respect as valuable resource for information on applications of complex products, including psychotropic medications. As recognition of exceptional product knowledge, selling skills, and territory management, I was appointed district trainer for new representatives.

PROFESSIONAL EXPERIENCE (cont)

Product Development Chemist (August 1982 - March 1984)

Sherwood Medical, Monoject Division - St. Louis, MO

Responsible for development of new products to complement a line of medical devices designed for use in medical laboratory procedures. In addition to supervision of technical development, I participated in product design, market analysis and incorporation of new products into manufacturing. I successfully designed, tested and initiated manufacturing of a blood collection tube for use in blood culture procedures.

Research Technologist (September 1978 - August 1982)

Washington University Medical Center - St Louis, MO

Experience included several facets of biological and biochemical research. Major area of study involved investigation of mechanism of drug resistance in microorganisms. Performed 'in vitro' and 'in vivo' testing, utilizing various techniques, including: tissue culture, radioimmunoassay, microscopy, spectroscopy, and monoclonal antibody production. Participated as coauthor of studies presented as articles in scientific journals, and displays at professional meetings.

EDUCATION

B. S. Chemistry/Biology, 1978 , West Chester University

West Chester, PA

VOLUNTEER ACTIVITIES

Chelmsford Alliance for Education (1990-present)

Chelmsford, MA

Founding member, and currently Vice President of this grass roots community organization designed to support and encourage change in the Chelmsford public schools. Instrumental in sponsoring speakers for public seminars on education, researching and sponsoring select programs for in-servicing of teachers within the system, as well as serving as liason for a student career shadow program coordinated through the guidance department of Chelmsford High School.

Chelmsford Public School System(1988- present)

Chelmsford, MA

Participated in a variety of volunteer programs, including chairperson for annual science fair at elementary school, representative for the Chelmsford Council of Schools, and served as member of Math Curriculum Committee.

HUBERTUS G. 'ROB' QUADEN
6 McIntosh Road
Chelmsford, MA 01824
(508)250-9578

EDUCATION

LESLEY COLLEGE GRADUATE SCHOOL OF EDUCATION, Cambridge, Massachusetts.
Master's Degree in Education, December 1978.

KATHOLIEKE PEDAGOGISCHE ACADEMIE, Maastricht, The Netherlands. BA
equivalence, May 1976. Specializations: mathematics, art.

MOLLER INSTITUTE, Tilburg, The Netherlands. Studied formal mathematics and
physics.
Transferred July 1973.

EXPERIENCE

CARLISLE PUBLIC SCHOOLS, Carlisle, Massachusetts, *Math Teacher*, 1981-
present, *Math Curriculum Coordinator*, 1992-present.
Teach students in grades six through eight: general math through algebra I.
Responsible for math curriculum renewal in grades k-8 and professional development to
support the renewal.
Developed computer curriculum for grades six through eight.
Supervisor of computer hardware.
Advisor Math League Team and Math Counts Team.
Recipient of Carlisle Superior Service Award (1984).
Recipient of Horace Mann Award Grants (1986, 1987).
Recipient of MASCD Peter Farely Award (1993).

MIDDLESEX COMMUNITY COLLEGE, Bedford, Massachusetts, *Instructor in
Mathematics*, 1988-present.
Teach courses ranging from Algebra through Precalculus.

ST. MARGARET SCHOOL, Seat Pleasant, Maryland, *Math Teacher*, 1979-1981.
Taught math in grades six through eight.
Responsible for revision of math curriculum.
Set up mathlab and cooperative activities with science teacher.

NEWTON PUBLIC SCHOOLS, Newton, Massachusetts, *Special Education Assistant*, 1978-1979.

FIRST FEW STEPS, INC., Worcester, Massachusetts, *House-manager and Counselor*, 1977-1978.

Supervisor of direct service staff, wrote and maintained Individual Service Plans in group home for mentally retarded adolescents.

ADDITIONAL ACTIVITIES

CHELMSFORD ALLIANCE FOR EDUCATION, *Secretary*, 1992-present.
Community based work to support education at the local level.

MIDDLE SCHOOL ALLIANCE NETWORK, *Workshop Presenter*: "Connections in Mathematics", November 1992; 'Modeling the Jury Process: An Interdisciplinary Math-Social Studies Unit', November 1994.

WORKSHOP ON CHAOS AND FRACTALS, BOSTON UNIVERSITY, *Participant*, July 1994.

EASTERN MASSACHUSETTS MATH LEAGUE, *Vice-president*, 1986-1992.

BOSTON UNIVERSITY, HARVARD UNIVERSITY, UMASS-LOWELL, *Student*, 1984-1988.

Miscellaneous course work in mathematics.

COMPUTER ASSISTED MATH PROJECT, UMASS, AMHERST, *Participant*, 1986-1987.

Development of math materials at the secondary level.

PRINCIPAL'S CENTER, HARVARD UNIVERSITY GRADUATE SCHOOL OF EDUCATION, *Workshop Leader*: 'Collegiality As A Component Of Improving Schools', April 1986.

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS

National Council of Teachers of Mathematics
Association of Teachers of Mathematics in New England
Massachusetts Associations for Curriculum Development

Linda J. Murdoch

26 Crooked Spring Road, West Chelmsford, MA, 01863
(508) 251-4736

EMPLOYMENT:

Educational Consultant Consulted on staff training, parent education, curriculum development, early intervention screening and referral, fundraising, marketing, NAEYC accreditation, and financial management in the early childhood setting. (1991-present)

Executive Director Directed overall non-profit early childhood school operation including staffing, budgeting, marketing, program supervision, and facility management. Helped coordinate development, funding, and implementation of two facility expansion projects at Chelmsford Children's School, Chelmsford, MA. (1989-1991)

Lead Teacher and Assistant Administrator Taught early childhood classes, including curriculum development, classroom management, and ongoing assessment of children's development and progress, preschool and toddler levels. Assisted in the opening of a new facility and program at Chelmsford Children's School, Chelmsford, MA. (1988-1989)

Emergency Child Care Provider Provided safe and nurturing home child care on a temporary, back-up and emergency basis for several Chelmsford, MA families. (1985-1988)

Program Director Developed branch programs including staffing, budgeting, promotion and community outreach. Directed nursery school at Waltham Branch of the Greater Boston YMCA, Waltham, MA. (1983-1985)

Associate Executive Director Created branch programming including staffing, budgeting, and promotion. Developed and directed nursery school. Negotiated contracts with local school districts and recreation departments at North Area YMCA, Syracuse, NY. (1979-1982)

Aquatic Director Developed aquatic programming including staffing, budgeting and promotion. Assisted in the planning, policymaking and opening of a full-facility YMCA at the North Area YMCA, Syracuse, NY. (1979)

Social Recreation and Camp Director Established year-round camp operation and club-wide feature events including program development, staffing, budgeting, marketing, and facility management. Completed proposal writing and fund administration resulting in the construction of a 22-stall horse barn and education center and other facility improvements at Binghamton Boys' and Girls' Club, Binghamton, N.Y. (1977-1979)

CERTIFICATION:

Commonwealth of Massachusetts: Office for Children Early Childhood Certification for Director I and Lead Teacher for Infant/Toddler and Preschool

EDUCATION:

Wheelock College: Child Care Administration, graduate level (May 1990)
Advanced Child Care Administration, graduate level (June 1991)

University of Vermont: B.S. Degree in Education, cum laude (May 1975)
Field Placements: Admissions, Student Academic Advising,
Career Planning and Placement, and Financial Aid

COMMUNITY INVOLVEMENT:

Chelmsford Public Schools: Reading and Language Arts Curriculum Review Committee (1993-1994)

Harrington Elementary School: Ed. Reform School Council (1993-present); Publishing Center (1990-present); PTO - President, Newsletter Editor, Collectors' Night (1990-1994)

Parker Middle School: Computer Room Instructor (1992-1994); PTO - Science Fair Committee, Invention Convention Committee (1992-present)

Council for Chelmsford Schools: President, School Representative, Town-wide Transition Committee (1992-present)

Chelmsford Alliance for Education: Steering Committee (1993-present)

Chelmsford Early Childhood Advisory Council: Chairperson, Literature Kit Grant Collaborator (1987-1994)

West Chelmsford Methodist Church: Family Ministries Chairperson, Auction Chairperson, Education Committee (1990-present)

Chelmsford League of Women Voters: Secretary, Steering Committee, Day Care Study Committee (1984-1994)

Fresh Air Fund: Host Family (1976-present)

Martha's Vineyard Camp-Meeting Association: Board Member, Program Committee Chairperson, Children's Art Show Director, Sunday Children's Program Director, Leaseholder/Public Relations Committee Chairperson (1991-present)

Massachusetts Department of Social Services: Foster Parent (1988-1989)

Chelmsford Newcomers' Club: President, Ways and Means, Newsletter Editor (1983-1986)

American Camping Association: Upstate New York Section - President, Vice-President for Quality Control, Accreditation Standards Visitor, Camping Conference (1977-1982)
New England Section: Accreditation Standards Visitor (1982-1990)

ANNEMARIE SMART
223 Riverneck Road
Chelmsford, MA 01824
503-256-4254

EDUCATION

Lesley College Cambridge, MA MEd, 1990 3.98 GPA
Computers in Education: Developed totally integrated
kindergarten curriculum with an emphasis on thinking skills
and technology.
Framingham State College Framingham, MA BS, Education 3.3 GPA
Kappa Delta Pi
Graduate level courses related to education at various
institutions, minimum 1 per year since 1990.

Certifications

Massachusetts Elementary Certification
Massachusetts Elementary Principal Certification
Massachusetts Supervisor/Director Certification
HOTS - higher order thinking skills curriculum
Woodcock-Johnson - pending - diagnostic testing and interpretation
Gesell - developmental testing and interpretation
Lego Logo instruction
Developmental Prescriptive Arithmetic - manipulative math
curriculum

EXPERIENCE

| | | |
|----------------------------------|-------------|--------------|
| <u>Maynard School Department</u> | Maynard, MA | 1975-present |
| <u>Chapter 1 Director</u> | | 1982-present |

- Design and implement Chapter 1 Program.
- Write grants.
- Organize inservice training for Chapter 1 staff.
- Research and implement new programs to maximize student success.
- Recommend specific alternative strategies for staff to use with students who are not achieving with current models.
- Liaison between classroom teachers, Chapter 1 teachers, administration, parents, and state to optimize instruction for each individual student.
- Hire and supervise up to 10 teachers and tutors.
- Plan and implement budget, including all required federal and state forms and reports.
- Pro-actively anticipate and diffuse problems.

Accomplishments:

- Originated and implemented Chapter 1 Program in Maynard.
- Research and observe current trends in education including HOTS, Reading Recovery, Math Their Way, Accelerated Schools, heterogeneous grouping, and Project Read.
- Implemented inclusionary model of instruction for Chapter 1.
- Implemented higher order thinking skills (HOTS).
- Implemented Developmental Prescriptive Arithmetic (DPA), a hands-on math program.
- Implemented Lego Logo in regular education classrooms.
- Developed and maintain a positive rapport with chapter 1 staff, teaching staff, administration and state officials which creates the best possible program for the students.

Green Meadow School

Maynard, MA

Teacher

1976-1982

- Taught remedial reading and math (grades 1-4).
- Administered diagnostic tests for reading and math.
- Developed programs for students' individual needs.
- Implemented programs.
- Communicated with parents and classroom teachers.
- Researched new materials and models for instruction.
- Scheduled children for instruction.

Accomplishments:

- Implemented Chicago Mastery Reading and Study Skills.
- Developed a positive rapport with students, parents, classroom teachers and administrators.

Kindergarten Assistant

1975-1976

Affiliations

Massachusetts Council of Administrators of Compensatory Education
Member of the executive board for 4 years; Treasurer for 2
years; current member in good standing.
Association of Supervisors and Curriculum Directors
Chelmsford Alliance for Education

Sara White

Movement Therapist and Teacher

Sara White is a certified teacher of Body-Mind Centering. She also is certified as a Laban Movement Analyst and a NeuroDevelopmental Treatment Educator. She has a background in dance, improvisation and Authentic Movement, and danced professionally in New York City for three years. Her career development began with an initial interest in dance, progressed to artistic refinement and then advanced to developing specialized skills in movement facilitation, particularly observation and analysis. Currently she has a private practice in Arlington, MA, which includes re-training for clients with movement problems: post-injury, developmental issues and the functional and/or expressive usage of the body. Teaming with a colleague, she has created and taught 10-week courses and two-day workshops in experiential anatomy in the Boston area. She has been teaching body work undergraduate courses and workshops continuously since 1978.

☐ Education:

B.A. Dance, University of Maryland, College Park, MD (1978)

M.F.A. Candidate, Dance, Smith College, Northampton, MA (1980-81)

☐ Certifications:

Therapeutic Massage & Bodywork, National Certification Board, #3656 (1993)

Massage Therapist (AMTA), Potomac Massage Therapy Institute, Washington, DC (1979)

Laban Movement Analysis, Laban Institute of Movement Studies, NY, NY (1979)

Neurodevelopmental Treatment, Educator, (210 hours), Georgetown University (1979)

Body/Mind Centering Practitioner and Teacher, 800 hours, by Bonnie Bainbridge Cohen, O.T., School for Body Mind Centering, Amherst, MA (1977)

☐ Current Employment:

1991-1994

Movement Therapist in private practice, associated with New Wings Psychotherapy Practices, Arlington, MA

On-going individual and group work with children and adults. Work includes re-training for clients with movement problems (post-injury, developmentally based issues, functional and expressive usage of the body). Process includes developing the individualized, sequential health plans and providing the therapy.

1991-94

Teacher and Curriculum Developer

• **Courses:** Developed curriculum and taught basic and advanced ten-week courses, including:

- *Experiential Anatomy* - advanced classes, designed for hands-on practitioners with previous anatomy training. Useful for bodyworkers and massage therapists, physical and occupational therapists, yoga teachers and movement educators.

- *Developmental Movement* (Basic and Intensive)

- *The Skeletal-Muscular Series*

Teacher and Curriculum Developer (continued)

- **Workshops:** Developed weekend "Pocket Workshops" (Two, half days) to enable more working professionals to participate in continuing education and skills development.
 - *The Joint Series of Pocket Workshops: Feet and Pelvis, The Knee, The Spine*
 - *Authentic Movement and Body-Mind Centering Principles*
- **Teaching Assistant:** for the course *Adult Human Neurology*, Springfield College, Springfield, Massachusetts, 1992

☐ Continuing Education (Selected highlights):

- Workshop - *Tension Flow Analysis - Baby and parent movement and interaction* - by Arnhilde Buelte, Assistant to Dr. Judith Kestenberg of the Prevention Center for Early Childhood Development, Long Island, NY (1977)
- Conference - *Laban Movement Analysis*, Hampshire College, Amherst, MA, (1978)
- Conference - *Neurodevelopmental Treatment: Sequential Development and/or Treatment Programs for Perceptually Handicapped Individuals*, Boston University School of Medicine, Boston, MA (1980)
- Conference - *Growth and Development of the Nervous System in Relationship to Movement*, by Dialogues in Contemporary Rehabilitation, Mt. Sinai Hospital, Hartford, CT 14 CEUs, (1980)
- Course - *Authentic Movement*, intensive one year internship with Janet Adler, D.T.R., Northampton, MA, (1981-82)
- Conference - *Motor Learning and Control*, Teachers College, Columbia University, NY 14 CEUs (1992)
- Conference - *New Perspectives on Facilitation of Functional Movement Skills*, ERI, Medfield, MA 6 CEUs (1993)

☐ Professional Affiliations:

- Associated Bodywork and Massage Professionals
- Massachusetts Professional Bodywork Association (MPBA)
- Member, MPBA committee to create criteria for professional licensing (1992-93)
- Member, Body Mind Centering Associates committee to create criteria for professional licensing (1992-93)

☐ Community Service:

- Chelmsford Cooperative Nursery School, Chelmsford, MA - President, 1989-90
- Developed *ABC: Above and Beyond in Chelmsford Schools* - after school enrichment program encompassing wide range of arts, sciences, crafts and recreational activities for town elementary schools (1991-92)
- Developed and taught creative movement course for South Row Elementary School, Chelmsford (1991)
- Council of Chelmsford Schools, Chelmsford, MA - Vice President, 1992-93
- Chelmsford Alliance for Education, Member, 1992-Present
- Chelmsford Middle School Advisory Council, Member, 1993 - Present

ODLUM, MARTELL & ROBERTS

ATTORNEYS AND COUNSELLORS AT LAW

500 CLARK ROAD

TEWKSBURY, MASSACHUSETTS 01876

TELEPHONE (508) 851-5000

FAX (508) 851-5729

OF COUNSEL

THOMAS C. TROY

JAMES J. DOHERTY

JOHN KEVIN DONOVAN *†

ROBERT J. ODLUM
MICHAEL A. MARTELL
J. ALAN ROBERTS

INVESTIGATOR: WILLIAM J. COUGHLAN

PARALEGAL: JOANNA PAQUETTE

*MEMBER: WASH D.C., CALIF. MASS BARS
†CERTIFIED SPECIALIST: TAXATION LAW &
IMMIGRATION LAW, STATE BAR OF CALIF.

February 14, 1995

Executive Office of Education
Commonwealth of Massachusetts
1 Ashburton Place
Boston, MA. 02108

Re: Chelmsford Public
Charter School

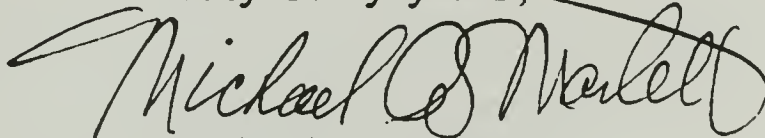
To Whom It May Concern:

I am familiar with some of the people involved in the Chelmsford Alliance For Education and believe they are competent people of integrity undertaking a worthwhile goal.

I would be willing to make myself available to the Alliance should they have any legal questions.

If you have any questions, please don't hesitate to call me.

Very truly yours,



Michael A. Martell

MAM:dt
cc Chelmsford Alliance for Education

THE UNIVERSITY OF CHICAGO
DEPARTMENT OF CHEMISTRY
JANUARY 1954

RECEIVED
JAN 15 1954

TO THE DIRECTOR

FROM THE DEPARTMENT OF CHEMISTRY

RE: [illegible]

The following is a summary of the results of the experiments conducted during the past year. The work was carried out in the Department of Chemistry, University of Chicago, under the direction of [illegible]. The experiments were designed to determine the effect of [illegible] on the rate of reaction of [illegible] with [illegible]. The results show that the rate of reaction is increased by the presence of [illegible]. The effect is more pronounced at higher concentrations of [illegible]. The mechanism of the reaction is not yet known, but it is believed that the reaction proceeds through a series of steps involving the formation of a complex between [illegible] and [illegible].

Very truly yours,
[illegible]

Enclosed are [illegible]

APPENDIX "B"

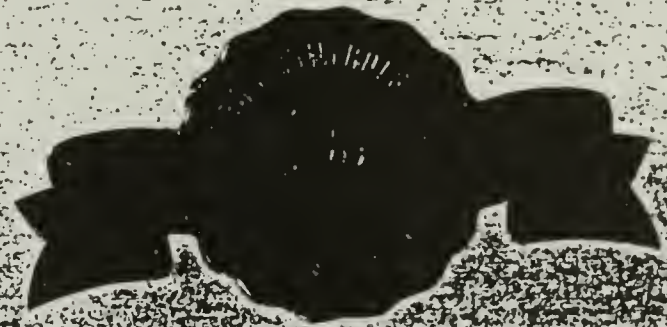
LETTERS OF SUPPORT

APPENDIX A

LETTERS OF BUREAU



HARBOR CONTROLS INC.



121 Brick Kiln Road
Chelmsford, Ma 01824
508-453-2323
outside of MA 800-225-1266
FAX 508-453-1166

February 3, 1995

Chelmsford Alliance for Education
PO Box 152
Chelmsford, MA 01824

Dear Alliance Members,

Your concept of a Charter School in Chelmsford, MA, warrants support from the community and local businesses.

On reviewing your proposal, it is evident that the education issues you are seeking to correct are prevalent in a majority of our public systems. Your concept of having subjects flow; Science to math thru English is a practical approach to education, worthy of implementation. In the business world we emphasize the manufacture of products from raw materials to finished goods, to customer application, and further show our employees a picture in it's entirety, through these means. As a result we seek employees who are perceptive enough to link their knowledge and apply it in a working environment.

Having a hands on, holistically integrated education system of choice is a reasonable and prudent proposal and it is a pleasure to draft a letter to you supporting the concept. Good luck with your submittal and please keep us posted on the outcome.

Sincerely,

Jay P. Tilley
VP Operations

**Massachusetts
Corporation for
Educational
Telecommunications**

One Kendall Square
Building 1500
Cambridge, MA
02139-1562

Tel: 617.252.5700
Fax: 617.252.5709

Richard J. Snyder, Esq.
Chairman

Dr. John G. Flores
Executive Director

Ms. Nina Lewin
Chelmsford Alliance for Education
P. O. Box 152
Chelmsford, MA 01824

Nov. 7, 1994.

Dear Nina,

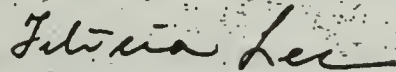
I would like to thank you, Arlene, and Rob, for coordinating the informational meeting held on October 18. Like many other Chelmsford parents that I have talked to, I respect you all for your commitment to high quality education and for all your work.

As Director of Education at MCET, I am familiar with the Education Reform Act, the Common Core of Learning, and the many drafts of the National Standards and the State Curriculum Frameworks. As a parent of three school-aged children, I am excited about the possibility of a charter school in Chelmsford, and how closely it relates to these initiatives. Clearly, we all agree that our children should be given every opportunity to become successful as creative, interested, concerned, and responsible citizens. A charter school which promotes the inquiry method and cooperative learning will certainly provide an environment for students to achieve their best. Although the charter school will start as a small alternative school, it nevertheless will have tremendous potentials to become a model learning institution.

It is never easy to start up a school. I am certain that you will receive support from various public and private sectors. Should I be of any help, please do not hesitate to call upon me.

Congratulations on all the good work, and best wishes to you all.

Sincerely yours,



Felicia Lee



JEFFREY E. KEAN, PH.D

Licensed Psychologist

73 Princeton Street
North Chelmsford, MA 01863
(508) 251-7887

8 Mason Street
Winchester, MA 01890
(617) 729-1029

February 13, 1995

Nina S. Lewin, President
Chelmsford Alliance for Education
P.O. Box 152
Chelmsford, MA 01824

Dear Ms. Lewin:

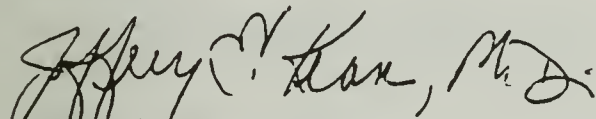
Having read the Chelmsford Public Charter School proposal, I am pleased to support your application. I believe that the school's commitment to a nonleveled, student centered, integrated and interdisciplinary environment affords a wonderful incentive for students to become active thinkers and participants in their education.

As a mental health provider, I have seen several dozen middle school students whose current learning environments fail them. These students often feel "turned off" to school because they see no connection between the curriculum and their present and future lives. They have learned to be passive students; they evidence boredom every day; and make minimal effort on a good day. When their evaluations reflect low achievement, they feign satisfaction, yawn and tune out again. Clearly, the Charter School approach offers such students a plausible alternative to the traditional middle school environments currently available to students in Chelmsford.

I further endorse your goals regarding personal and social development since I have argued for years that the schools should provide more explicit recognition of preadolescent and adolescent issues and needs. Your proposal outlines an exciting and extraordinary support system. And the daily "family meetings" component offers an excellent avenue to foster healthy social and personal growth and to assist students in taking positive responsibility for their actions in and out of the classroom.

I heartily endorse your application, and I wish you luck.

Sincerely,


Jeffrey E. Kean, Ph.D.

THE JOURNAL OF THE
ROYAL ANTHROPOLOGICAL INSTITUTE

Volume 100
Part 1
January 1970

Published by the
Royal Anthropological Institute
of Great Britain and Ireland

Editor: J. H. REES

Editorial Board:
J. H. REES (Chairman)
D. M. S. LEITCH
J. M. SMITH
J. C. SMITH

Editorial Office:

Department of Anthropology,
University of Cambridge,
Downing Street, Cambridge CB2 3RQ,
England

Subscription prices (per volume):
Institutional subscribers: £100.00
Individual subscribers: £25.00
Single issues: £5.00
Orders should be sent to the
Royal Anthropological Institute,
21, BEDFORD SQUARE, LONDON, W.C.1A 2EJ

Advertising rates: £10.00 per line per month
Orders should be sent to the
Royal Anthropological Institute,
21, BEDFORD SQUARE, LONDON, W.C.1A 2EJ

Copyright © 1970 by the
Royal Anthropological Institute

Printed by
The Cambridge University Press
Printers, Cambridge

Katherine Harbison
28 Charlemont Court
N. Chelmsford, MA 01863

Ms. Nina Lewin
Chelmsford Alliance for Education
P.O. Box 152
Chelmsford, MA 01824

February 12, 1995

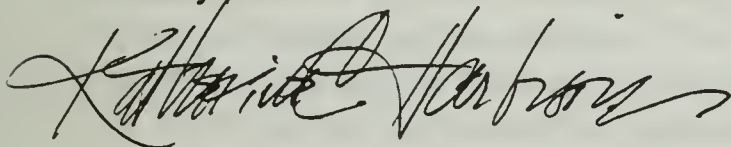
Dear Ms. Lewin,

After many months of observing from the periphery, I am able to finally, and without reservation, extend my unqualified and enthusiastic support for your efforts to bring a Charter School to Chelmsford. As an individual parent, I still do not expect my own children to be directly effected by the availability of an alternative to our two Middle Schools, but as an informed and involved community member, I believe a true need exists for a middle school based upon the structure and philosophy set forth in your proposal.

The passage of Education Reform at the state level felt like a legislative "breath of fresh air", but I have realized during the past year that legislating reforms and readily implementing them at the local level are two different things. It's not that we have bad schools in Chelmsford — we don't; it's not that we have bad teachers in Chelmsford — on the contrary, we are lucky to have some truly motivated and innovative staff; it's not that we have an unresponsive central office — our current administration is remarkably amenable to notions of change. What we do have is a large system that simply *cannot*, because of traditional constraints of size and political reality, move quickly enough to consistently embrace system-wide innovation at a pace that will benefit our current middle school age students.

Should your dream of a Charter School come to fruition, I hope it will serve as a shining example of what can be accomplished for children under the auspices of public education. I wish you success in your continuing efforts to improve and strengthen our public schools.

Sincerely,

A handwritten signature in dark ink, appearing to read "Katherine Harbison", written in a cursive style.

Katherine C. Harbison

Daniel W. Dubner, M.D.
Janet Dubner, MS. Ed, CAES
46 Dalton Road
Chelmsford, MA 01824
508-256-8216

November 15, 1994

To the Selection Committee for Charter Schools:

We write this letter in support of the Chelmsford Alliance for Education's application to develop a Charter School in Chelmsford. We have three children in the Chelmsford Schools (5th, 8th, and 11th graders) and have always been actively involved in their educations. As a pediatrician and a school psychologist/special education case manager, we are also actively involved in the education of many children.

Education has changed in many ways in the past two decades, not the least of which has been due to economic issues. Buzz words in every school mission statement support individualizing each student's education to maximize his or her unique interests and talents while providing support to remediate or compensate for weaknesses.

Chelmsford has always taken pride in its public schools. While there is quality in many of the educational offerings, cutbacks have resulted in a lack of choice in teaching methodologies and expectations. With the possible exception of students serviced under Chapter 766, little effort is made to provide alternatives to traditional learning styles. This is particularly true in the middle school grades. Middle School is often a difficult time for children developing into adolescents. Standard methods of teaching often leave these children disinterested and, at worst, turned off to education. While we pay lip service to the idea that children learn in many different ways, most educational programs do not embrace this concept wholeheartedly.

The proposed Charter School carries forth the general intent of the Chelmsford Public Schools to provide an integrated curriculum based on the Systems Dynamics philosophy that one goes from looking at the general (or whole) to understanding the specifics (parts). Teachers do not lecture so much as facilitate learning. Home and family are crucial components in the educational process. This Charter plan would add a special dimension to quality education and should be welcomed by the Chelmsford Public Schools as an appealing alternative to traditional classroom teaching. It would appeal to a wide range of students who would thrive on the hands-on approach to learning.

Please give this application careful consideration. The proponents have carefully investigated both the concept and the realities of the Charter School proposal and are well-qualified to supervise and bring to fruition this creative and exciting alternative. Ideally it should be located in one of the existing school buildings so that the students would not be completely isolated from their peers. However, it can also be successful as a free-standing program.

Sincerely yours,

Daniel W. Dubner
Janet Dubner

January 30, 1995

Nina Lewin
Chelmsford Alliance For Education
P.O. Box 152
Chelmsford, MA 01824

Dear Nina:

Our family is in complete support of the proposed Charter School here in Chelmsford. We feel very strongly that this concept will be extremely beneficial to our educational system. Please keep us advised of your progress. We surely hope our son Justin will, at least, have an opportunity to be a part of this exciting alternative to our present situation.

Sincerely,

Kathy & Tim

Kathy and Tim Wilson

13 Braeburn Road
Chelmsford, MA 01824
(508) 256-4414

October 19, 1994

Ms. Nina Lewin, President
Chelmsford Alliance for Education
P.O. Box 152
Chelmsford, MA 01824

Dear Ms. Lewin:

Last night I attended the community meeting the Alliance for Education held regarding the proposed charter school. Your group presented an exciting venture for our children and our town! As an early childhood educator I have long since held the view that curriculum must be hands-on and integrated in order for learning to be meaningful. Teachers must be more than instructors, they must be involved in the process of discovery. I wholeheartedly support the Alliance in its attempt to secure approval as a charter school in the Commonwealth of Massachusetts.

None of my four children may ever be able to benefit directly as students in the proposed school. My eldest step-son is too old to be included. My eight year old would not be eligible for a few more years. Nevertheless I believe this is an important opportunity for change and improvement in our school system. If I can be of assistance in your work please contact me.

Sincerely,

Susan M. Mackinnon

Susan M. Mackinnon

40 Walnut Road
Chelmsford, MA 01824
256-3479

**Marion Sundgaard
2 Marina Road
Chelmsford, MA 01824
508-256-9394**

February 5, 1995

Piedad Robertson,
Secretary of Education
Executive Office of Education
One Ashburton Place
Boston, MA

RE: Chelmsford Public Charter School Proposal

Dear Secretary Robertson:

I am writing in support of the proposal by the **Chelmsford Alliance for Education** for a charter school in **Chelmsford, MA**. I am a life long resident of Chelmsford; New England Regional Councilor of the Education Division of the American Society of Quality Control; possess a graduate degree in Training & Development; and an undergraduate degree in Organizational Behavior; am a Total Quality Management (TQM) Specialist; and an ISO9000 Certified Lead Assessor; am a member of the Human Resources Network; and the Association of Affirmative Action Professionals, of which I have been a keynote speaker. I feel it is important that we adequately prepare children so that they can function effectively in today's ever changing diverse world. The skills needed by the student of today are very different from those skills around which traditional education was based fifty years ago. The proposal for the **Chelmsford Public Charter School** outlines an approach to education which I believe will very effectively provide students with an opportunity to gain the skills needed to compete in the global workplace they will be entering.

It is important to provide practical alternatives to the very traditional education provided for students in Chelmsford. Although the public schools have enjoyed a good reputation, that reputation was in large part earned twenty to thirty years ago, and the system is in many ways unchanged. The Education Reform Act is driven by a need to bring our schools and teaching methods into the twenty-first century and beyond. It is very difficult, however, to affect significant change within a system the size of the Chelmsford public schools. The proposed charter school would provide a wonderful opportunity, not only for the students who would attend the school, but also, as an effective and much needed catalyst for change within the public school system.

I am acquainted with several members of the founding coalition, and I know them to be knowledgeable, practical individuals, with a commitment to improve the quality of education available to students at all ability levels. I therefore strongly urge you to approve the proposal from the Chelmsford Alliance for Education for a charter school.

Sincerely,

Marion Sundgaard
Human Resources Manager
EEO/AA Officer

To Whom It May Concern:

I am writing to express my support for an alternative program for the middle school students in Chelmsford. I believe that an alternative program is important and beneficial for all the students in the Chelmsford public school system.

I am the parent of three children. It has been our good chance to have experienced an alternative school setting for our oldest child. He began his formal schooling in an alternative school in California, and I believe that because he was a good fit for the particular philosophy and teaching methods of the school that he has developed a love for learning. He has adapted to the public school system, and has had good and bad experiences, but always remembers his beginning years with fondness and wishfulness.

I believe that all students would benefit from an alternative approach because it would be in a setting that requires constant ongoing evaluation and assessment. What approaches are successful would be apparent much more quickly in a smaller group, and adaptations for all the students could be made.

The opportunity to bring in a different method of learning is an exciting one, and I am hopeful that this opportunity will not be missed.

Thank you,

A handwritten signature in cursive script that reads "Elaine Kahn". The signature is fluid and elegant, with a long horizontal stroke at the end.

Elaine Kahn

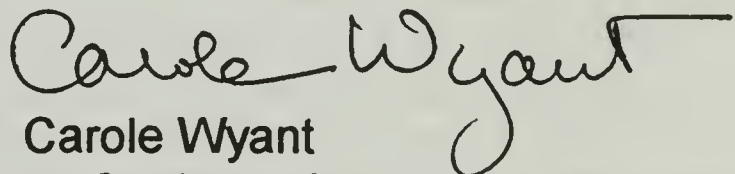
Chelmsford Alliance for Education, Inc.
P.O. Box 152
Chelmsford, Ma. 01824

February 5, 1995

To Whom it may concern:

I am writing you to voice my support for the proposed Charter school in the town of Chelmsford. As our family has a long history of educators on both sides, we firmly believe in the importance of education. We further feel that the interdisciplinary approach as proposed for the Charter school is a better approach for preparing our children for the challenges of the next century. We hope that you will approve the Charter school and believe that it will be a great success.

Sincerely,

A handwritten signature in cursive script that reads "Carole Wyant". The signature is written in dark ink and has a long, horizontal flourish extending to the right.

Carole Wyant
79 Stedman Street
Chelmsford, Ma. 01824

33 Adams St.
N. Chelmsford, MA 01863
February 6, 1995

Piedad Robertson
Secretary of Education
Executive Office of Education
Commonwealth of Massachusetts
Boston, MA

Dear Ms. Robertson,

I am writing to convey to you my support of and enthusiasm for the Chelmsford Alliance for Education's petition for a charter school here in Chelmsford. I am a parent of four school-aged children in grades 11, 8, 7 and 4, all of whom are currently attending public school in Chelmsford, and although I have generally been satisfied with the traditional style of education, I do believe the system dynamics approach which is proposed for this charter school would be very advantageous to many students. This would be especially true for children such as my son, who is currently in the eighth grade. This is a child who thrives on "hands-on" learning activities and tends to be frustrated or even bored in classes that are taught with the teacher lecturing, the student note-taking and homework consisting solely of questions and answers out of a textbook. My son is a creative boy who loves to move and to work with his hands. The thought that children like my son may get the chance to experience a dynamic classroom setting such as is proposed by the Chelmsford Alliance for Education is very exciting to me. I also hope that if the charter is granted to this group that my youngest child may be lucky enough to participate.

I once again express to you as a parent and as a member of the Chelmsford community to please consider this proposed charter school for the educational benefit of Chelmsford's school children.

Sincerely yours,



Nancy L. Long

100-1000

100-1000

100-1000

100-1000

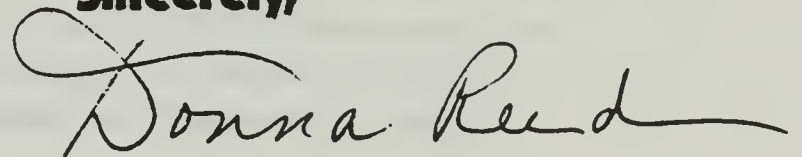
**6 East Sheppard Lane
Chelmsford, MA 01824
February 1, 1995**

Dear Mrs. Lewin,

Having seen you and Mrs. Parquette address the school committee on a number of occasions, I felt compelled to write to offer my opinion. I, too, support the concept of an integrated, hands-on approach to education for our children. I can't help but feel that it would be a benefit to our community if we were able to offer the "choice" that so many surrounding towns have yet to offer.

Please continue in your efforts: the town needs you. If there is anything I can do to help, please advise.

Sincerely,

A handwritten signature in cursive script that reads "Donna Reed". The signature is fluid and elegant, with a long horizontal flourish at the end.

(Mrs.) Donna Reed

February 4, 1995

Ms. Nina Lewin
Chelmsford Alliance for Education
Chelmsford, MA
01824

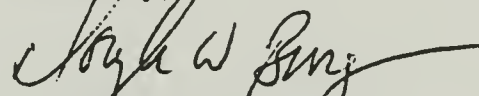
Dear Nina;

I am writing this letter in support of the Chelmsford Alliance for Education's (CAE) proposed Charter School plan. I believe the alternative teaching approaches to be utilized at the school can greatly enhance and improve the quality of education for all students.

Although most students will perform satisfactorily in a traditional learning style, there are some who will excel when approached from a different perspective. I think the philosophy behind the CAE's plan, which focuses on developing and applying skills to real world situations, is fundamental to children entering the continually competitive workforce of the 21st century. I currently have two children in the Chelmsford School System (Westlands School), with a third to enter the system this fall. They have done exceedingly well at Westlands, however I feel one of them could be doing far greater if alternatives were available. Her approach to understanding and solving complex problems is similar to the style proposed in the CAE plan, i.e., through the integration and application of different skills. I feel her participation in the Charter School could be beneficial in helping her attain the achievement levels she's capable of.

I am grateful to you and the CAE for its continued interest in education at the Chelmsford Schools, and for its leadership in introducing non-traditional learning processes. I urge you to continue your quest to establish the Charter School as an alternative learning center.

Sincerely,



Douglas W. Burgess
16 Fuller Road
Chelmsford, MA
01824

1891

1891

1891

1891

1891

1891

1891

1891

1891

1891

1891

1891

1891

Chelmsford Alliance for Education

November 9, 1994

P.O. Box 152

Chelmsford, Ma. 018824

Dear Alliance Members,

I am writing to endorse the Chelmsford Alliance's application for a charter school. As I understand, the emphasis of the school would be on problem, solving, creative thinking, teacher as facilitator not dictator, plenty of hands on and cooperative learning activities, using the scientific process.

I believe that children will find this form of education far more stimulating and interesting. Therefore, they will learn that much more. Not only will they learn more, they will learn how to learn better. They will be much better prepared to be responsible, productive citizens of the global society they will enter as young adults.

I am a concerned parent of children in the Chelmsford school system. I have also just started a Master's program to earn a degree in education. The kind of school the Alliance is talking about is the kind of school I would like to have my children in, and it is the kind of school in which I would like to teach.

Sincerely,

Ed Burns

Ed Burns

Susan Carr
6 Matthew Lane
Chelmsford, MA 01824


November 14, 1994

Ms. Nina Lewin, President
Chelmsford Alliance for Education
Chelmsford, MA 01824

Dear Nina,

I am writing this letter in support of your application to establish a charter school in Chelmsford. I am a parent of 3 school age daughters and I am also a Chelmsford Representative on the District School Committee of Nashoba Valley Technical High School. As both a parent and a School Committee member, I know the importance of a vocational education. The students at Nashoba thrive in its hands-on approach to education. Most of these students would have benefited from a hands-on, learner-centered education earlier in their school career but had to wait until high school to receive it. I wholeheartedly support the development of a charter school whose charter will be a hands-on approach to education.

Sincerely,

A handwritten signature in cursive script that reads "Susan Carr".

Susan Carr

Oct 31, 1994

To: The Chelmsford Alliance for Education,

We attended your recent information meeting concerning your efforts to create a charter school in the town of Chelmsford. We are enthusiastic about the opportunity your proposed school presents to the town and its children.

We are the parents of two students who have attended the Chelmsford Public Schools for six and eight years. One of our firm beliefs is that children learn in different ways. Your proposal is, to us, an option that would otherwise not be available to those children who would benefit by the systems dynamics approach you described.

We believe that your proposal can positively affect the entire Chelmsford School System and the community by offering an innovative approach to the education of our children - our most valuable resource.

We look forward to attending your next informational meeting, and hope that we can contribute to your efforts in the future.

Sincerely,

Peter Donahue

Paula Donahue

Peter and Paula Donahue
15 Doral Dr.

North Chelmsford, Ma 01863

19 Judith Road
Chelmsford, MA 01824

November 14, 1994

Chelmsford Alliance for Education
P.O. Box 152
Chelmsford, MA 01824

I have written this letter in support of the Alliance's application for a Charter School.

We have two children in the Chelmsford school system and think that this type of educational concept would be beneficial to our children. We are encouraged by the way that this program will allow children to put knowledge to work through direct application.

We fully support your efforts and hope that you are successful.

Debbie Page

Debbie Page

21.000

1.000.000

1.000.000

1.000.000

1.000.000

1.000.000

Susan McHugh

The Marketing Edge
Representing precision manufacturers

56 Central Square
Chelmsford, Massachusetts 01824
508-250-1975
FAX 508-250-1922

February 8, 1995

Chelmsford Public Charter School Committee
Chelmsford, MA 01824

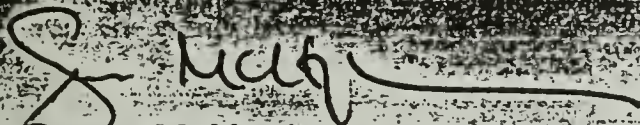
Dear Members of the Committee:

I have been reading about your charter school proposal in our local newspapers and have listened to much of the discussion your efforts have generated.

I think that all of us are looking for the best education possible for our children. Sometimes, though, we can lose sight of the fact that the "best" is not the same for every student. Within our student population there is diversity which challenges us to offer different options. I am writing simply to offer one voice of support. I believe we need options. I believe the entire school system will benefit by the creative energy and excitement that this project will generate.

As a parent, I appreciate your dedication to all of the possibilities within our public school system. I wish you success with your Charter School application.

Sincerely,



Susan McHugh

Chelmsford Alliance for Education, Inc.

P.O. Box 152

Chelmsford, MA 01824

November 1, 1994

To Whom it may concern,

I am writing to you, both as a parent and an educator to express my support for the Charter school in our town of Chelmsford. My family feels education is the most valuable experience one can receive. We believe that the interdisciplinary approach to teaching would better educate our children for the challenges of tomorrow. We do hope you will approve the charter school for Chelmsford. We know it will be a great success.

Thank you,

Dawn Martell

Dawn Martell

6 Lancaster Ave.

Chelmsford, MA 01824

Mr. and Mrs. David Kearns
35 Cathy Road
Chelmsford, MA 01824

Nina Lewin, President
Chelmsford Alliance for Education
Box 152
Chelmsford, MA 01824

Dear Ms. Lewin;

We would like to express our support for the proposed charter school in Chelmsford. We were very impressed with the organization and commitment of the Alliance for Education. The systems dynamics approach to education is a practical approach to learning that will benefit all ability levels of children. Developmentally appropriate educational methods appear to be lacking in any consistent way in Chelmsford public schools.

The charter school will offer students an alternative to the typically traditional education that is currently offered. It is our hope that the charter school will become a model and a catalyst for change within the Chelmsford schools. It is time for our school board to realize that change is needed in order to better prepare our children to enter the work force with the skills they need. Students working in a team environment to solve real problems applying the skills they are learning is a concept that is applicable to the present and future work force.

We encourage the Board of Education to approve the charter school for Chelmsford. Real change and progress take commitment and hard work. The Alliance for Education has done a thorough job of researching the need for change and developing a charter school model that will effect positive change within the schools. The Alliance for Education is well organized and committed to the success of the charter school.

The charter school will offer students the opportunity to learn and understand what they learn in a concrete way. The charter school will be a model for enthusiastic and meaningful learning.

Respectfully,

Mr. & Mrs. David Kearns

Mr. and Mrs. David Kearns

THE UNIVERSITY OF CHICAGO
LIBRARY

THE UNIVERSITY OF CHICAGO
LIBRARY
1215 EAST 58TH STREET
CHICAGO, ILL. 60637
TEL: 773-936-5000
FAX: 773-936-5001
WWW.CHICAGO.EDU

THE UNIVERSITY OF CHICAGO
LIBRARY
1215 EAST 58TH STREET
CHICAGO, ILL. 60637
TEL: 773-936-5000
FAX: 773-936-5001
WWW.CHICAGO.EDU

THE UNIVERSITY OF CHICAGO
LIBRARY
1215 EAST 58TH STREET
CHICAGO, ILL. 60637
TEL: 773-936-5000
FAX: 773-936-5001
WWW.CHICAGO.EDU

THE UNIVERSITY OF CHICAGO
LIBRARY
1215 EAST 58TH STREET
CHICAGO, ILL. 60637
TEL: 773-936-5000
FAX: 773-936-5001
WWW.CHICAGO.EDU

THE UNIVERSITY OF CHICAGO
LIBRARY
1215 EAST 58TH STREET
CHICAGO, ILL. 60637
TEL: 773-936-5000
FAX: 773-936-5001
WWW.CHICAGO.EDU

THE UNIVERSITY OF CHICAGO
LIBRARY
1215 EAST 58TH STREET
CHICAGO, ILL. 60637
TEL: 773-936-5000
FAX: 773-936-5001
WWW.CHICAGO.EDU

THE UNIVERSITY OF CHICAGO
LIBRARY
1215 EAST 58TH STREET
CHICAGO, ILL. 60637
TEL: 773-936-5000
FAX: 773-936-5001
WWW.CHICAGO.EDU

14 Footpath Road
Chelmsford, MA 01824
November 3, 1994

Chelmsford Alliance for Education, Inc.
PO Box 152
Chelmsford, MA 01824

Dear Alliance Members,

I was present at your recent meeting for the proposed charter school for Chelmsford. I am very excited about the program which you presented. As a parent of a daughter in grade four, I am particularly interested in the intergration of curriculum which you proposed as well as the opportunity of a "hands on" type of learning. I believe that these options offer an alternative to traditional middle school learning that is exciting both for parents and students.

Good luck in seeking your charter.

Sincerely,

Janet K. Morano

Janet K. Morano

1891
The
of

1891
The
of

1891
The
of

1891
The
of

1891
The
of

1891
The
of

1891
The
of

1891
The
of

Stephanie Greenwood
4 Woodlawn Avenue
Chelmsford, MA 01824

February 6, 1995
Chelmsford Alliance for Education
PO Box 152
Chelmsford, MA 01824

Dear Nina,

I am writing to you in support of the Chelmsford Public Charter School. I believe learning by doing is a means to learn that we as adults do every day. We need to teach our children how important it is to "try it and see if it works". Our children need to not just look at the end product or fact, but question how that product or fact was obtained. Hands on participatory learning is essential to looking at the complete picture.

The need for educators in the public school to practice hands on participatory learning is enormous. I am a parent of a third grader and feel his desire to figure it out for himself, and his questions, are naturally moving toward problem solving. I do not feel he is being encouraged to learn this way.

A teacher participating in the Chelmsford Public Charter School would take back to their classroom an invaluable teaching style that would receive great enthusiasm by the students. To ask the questions "Where can I take this information?" and "How can I broaden this outlook?", are essential to both teacher and student accomplishment.

I believe you are on the right track and I hope the Chelmsford Public Charter School is forthcoming. I also hope that the public school system recognizes the focus of your efforts and adopts some of that focus for all students.

Sincerely,

Stephanie Greenwood

MEMORANDUM
TO THE SECRETARY
FROM THE DEPARTMENT OF THE ARMY

DATE: 10/10/44
SUBJECT: [Illegible]
[Illegible]

[Illegible paragraph of text]

[Illegible paragraph of text]

[Illegible paragraph of text]

[Illegible paragraph of text]

[Illegible signature]

Mr. and Mrs. Kenneth S. Edwards
24 Brentwood Road
Chelmsford, MA 01824-1334
(508) 250-0509

February 9, 1995

Chelmsford Alliance for Education
Ms. Arlene Parquette, President
P.O. Box 152
Chelmsford, MA 01824

RE: Charter School Proposal for Chelmsford, MA

Dear Ms. Parquette,

We are writing this letter to endorse your Charter School Proposal for Chelmsford, MA. We attended the informational meeting the Chelmsford Alliance for Education held on the proposed Charter School as well as read the materials placed in our public library on the proposal. We have familiarized ourselves with Systems Dynamics upon which the school philosophy and teaching methods will be based.

We think this approach to education makes sense in our increasingly technological age and would not hesitate to place our child in this type of educational environment. We especially find it a viable and exciting alternative for the middle school learning years.

Thank you for your forward thinking for the education of Chelmsford students.

Sincerely,

K. S. Edwards Elizabeth R. Edwards

THE UNIVERSITY OF CHICAGO
DIVISION OF THE PHYSICAL SCIENCES
DEPARTMENT OF CHEMISTRY
5700 S. DICKINSON AVE.
CHICAGO, ILL. 60637

DATE: 10/1/77

TO: DR. J. H. DUNN
FROM: DR. J. H. DUNN
SUBJECT: 10/1/77

RE: 10/1/77

1. The following information was received from the
Department of Chemistry, University of Chicago,
Chicago, Illinois, on 10/1/77:

2. The following information was received from the
Department of Chemistry, University of Chicago,
Chicago, Illinois, on 10/1/77:

3. The following information was received from the
Department of Chemistry, University of Chicago,
Chicago, Illinois, on 10/1/77:

11 New Fletcher St.
Chelmsford MA 01824
January 31, 1995

Nina Lewin, President
Chelmsford Alliance for Education
1 Boyd Lane
Chelmsford MA 01824

Dear Ms. Lewin,

I would like to lend my support to the Alliance-proposed charter school. The Alliance has served as a non-partisan catalyst for change over the past several years, and the proposal you have presented for a middle grades school is both intriguing and exciting.

Because of the size and dynamics of our public school system, change is difficult to bring about. Class sizes are large, and parental involvement in the schools has been discouraged. I welcome the idea of a school where student, staff and parents work cooperatively to foster the most positive learning environment possible.

The hands-on curriculum you have described seems ideally suited to meeting the variety of learning styles found in the classroom. It is both learner-centered and practically oriented.

It is also encouraging that the school will so aptly meet not only the academic, but the social, physical and emotional needs of the students as well. As a parent of two children, one of whom may be eligible for the charter school, I look forward to hearing more about the progress of the school, and I sincerely hope the charter will be accepted by the state.

The school you describe would meet a very definite need in our community.

Sincerely,

Deborah L. Botham
Deborah L. Botham

1890

1890

1890

1890

Feb. 10, 1995.

To Whom It May Concern,

I am writing this letter to let you know that I not only support the idea of a charter school in Chelmsford, but that it is the reason I am considering staying in Chelmsford. When we moved here five and a half years ago it was because of the schools. We believed that Chelmsford had one of the better school systems in this area. They had relatively small class sizes and full time art and music teachers. Today I have a very different opinion. Children who are supposed to be in elementary school are being forced into middle school. With the way the class size has increased, grades 5 and 6 being shifted to middle school and the art and music teachers always in jeopardy of being cut, I have been considering moving to another town. I fear the Chelmsford school system is declining in its quality of education. News of the charter school has caused me to reconsider.

I have recently been studying the theories of learning styles, multiple intelligences and integrating the arts in education. One thing has become apparent to me, it is time to reform education. With all the new research that has been written on how differently people learn and acquire knowledge, why aren't schools changing their approach to teaching? I believe the proposal for this charter school will indeed charter new territory with education in Chelmsford. I hope to see my children attend. We need an alternative to the present education system. We need a school that is student centered and presents subjects in a more hands on approach. It is time to utilize the knowledge we have on how children learn. Their future is our future.

Please note that even though we have the same last name, I am not related to Nina Lewin.

Sincerely,



Susan Lewin

11 Carriage Dr.

Chelmsford, MA

February 2, 1995

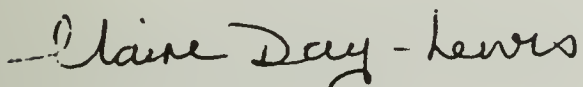
The Commonwealth of Massachusetts
Executive Office of Education

To Whom It May Concern:

I am writing to lend my support to the Chelmsford Alliance for Education.

As a mother of two children currently in the Chelmsford School system I naturally feel all avenues of teaching methods must be explored. Children learn in different ways and in these times of budget cuts and overcrowding, I feel not all of our children's needs are being met. Therefore, I am in favor of any options being made available to them.

Sincerely,



Claire Day-Lewis
15 Adams Avenue
Chelmsford, Ma. 01824



February 14, 1995

To: The Chelmsford Alliance for Education:

We are writing in support of your efforts to provide an alternative educational program within the town of Chelmsford. Having three children of our own, we recognize the need for a Charter School in Chelmsford. Certainly this school could provide the hands-on-approach which so many of our children would benefit from.

We certainly hope you are successful in your efforts and we both support you!

Jean W. Wilson
Harry R. Wilson

Patricia Pestana
Ward Rosenberry
30 Newfield St.
N. Chelmsford, MA

February 12, 1995

Chelmsford Alliance for Education
Chelmsford, MA

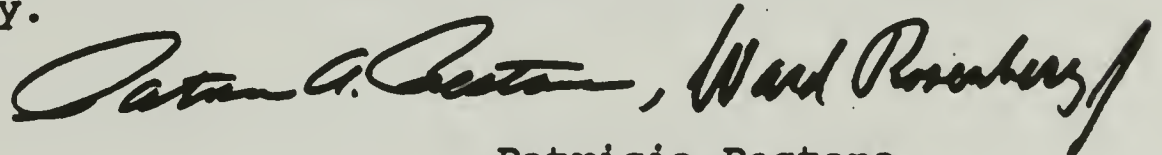
Dear Alliance Members,

We wish to express our unqualified support for your exciting proposal to create a charter school in Chelmsford. We believe that the integrated approach to learning that you propose would be of great benefit to our children and to the community as a whole. While we have generally been satisfied with the quality of the education our children have been receiving in the public schools, we have often found the curriculum to be lacking in the practical applications of knowledge. We frequently find ourselves having to explain to our fifth grader why a particular piece of information or set of skills is important to have. We have found that he most enjoys learning, when he has a "project" to work on. "Hands-on" learning becomes exciting for him and he will expend extra effort in his studies when he sees where he can apply what he has learned.

While a charter school will serve only a small segment of our school population, it will create the potential of enrichment for all students in our community. A small project of this sort can serve as an educational laboratory which can ultimately improve the entire system.

We also believe that our children will need special skills to be successful in the world marketplace of the future. Individuals who have been trained to think critically, to make connections, who can work with others in groups, who can be flexible and who can integrate knowledge from various disciplines, will be the ones most able to keep up with rapid changes in culture and technology. We believe that the program proposed by the Chelmsford Alliance for Education is one that can best prepare our children for the demands of the workplace of the future.

We congratulate you on your excellent proposal and offer our continuing support of your efforts towards establishing a charter school in our community.



Patricia Pestana
Ward Rosenberry

26 Crooked Spring Road
N. Chelmsford, MA 01863
February 10, 1995

Ms. Nina Lewin, President
Chelmsford Alliance for Education
P.O. Box 152
Chelmsford, MA 01824

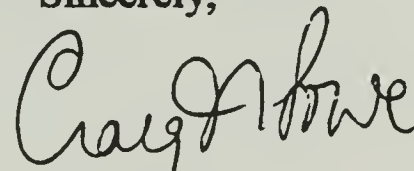
Dear Ms. Lewin:

Please accept this letter in support for the Charter School proposed by the Chelmsford Alliance for Education. I am impressed by the quality of the proposal and the amount of time your group has put into this endeavor.

As a long-time professional in the high tech industry, I believe the hands-on, problem-solving approach your school offers, as well as the integrated technology and opportunities for collaborative projects, would prepare students for the present and future work world. As a father of two sons, I know that my children learn best in this manner too. Unfortunately, this approach is only offered on a limited basis in the Chelmsford public schools. Your school would provide a needed alternative for students and parents.

I hope that you are successful in securing a charter and opening a charter school in Chelmsford. Both myself and my sons are excited at this prospect.

Sincerely,

A handwritten signature in cursive script that reads "Craig N. Lowe". The signature is fluid and written in dark ink.

Craig N. Lowe

10 February 1995

TO: Chelmsford Alliance for Education
P.O. Box 152
Chelmsford, MA 01824

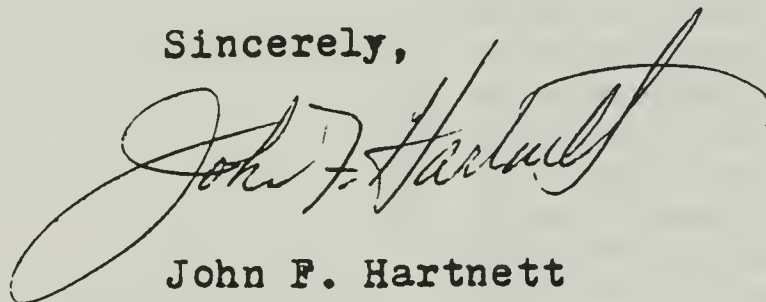
FROM: John F. Hartnett
6 Sherman St.
No. Chelmsford, MA 01863-1766

RE: Charter School

I have been involved for the past 28 years both in public schools and in the military. I feel that the quality of education in the public schools has been degraded by a large number of conditions and situations. One change needed today is to return to a student centered hands on approach. We need to turn away from a series of facts to be memorized and soon forgotten.

It is gratifying to see how this approach to education will be implimented by the Charter School. Perhaps this will be the turning point in the public educational system.

Sincerely,

A handwritten signature in cursive script, reading "John F. Hartnett". The signature is fluid and stylized, with a large loop at the end of the last name.

John F. Hartnett

1. Introduction

2. Methodology

3. Results

4. Discussion

5. Conclusion

6. References

7. Appendix

8. Acknowledgements

9. Contact Information

56-0141

their opinion about the proposed charter school. Unfortunately, it is too bad that some opinions are based on so much incorrect information. Charter schools *are* public schools as per the state law. They are accountable for meeting stated goals and objectives and they operate under the Open Meeting Law so the public can know what they are doing. The Alliance has prepared an excellent proposal that is based on proven educational principles and many children could benefit. Not every child has found success in the Chelmsford Public Schools. Innovative practices and exciting changes are not happening consistently. Why are we afraid of providing an alternative? Give this charter school a chance. Thank you."

Give charter school proposal a fair chance

"Everyone is certainly entitled to

Charter school idea is right for some

Three cheers to the people who are leading the movement to explore the possibility of a charter school in Chelmsford.

As the parent of two children — both of whom went through the Chelmsford School System and are now graduated, I would like to tell those opposed to the idea of a charter school this: The Chelmsford School System is good. But it's not for everybody. My oldest floundered the whole 12 years and barely graduated. Every day was a struggle. My youngest excelled at both sports and academics but was also unhappy. I'm convinced both would have thrived in the charter school setting.

I'd also like to address another point that's been raised: that the children will be isolated. The summer before I was to enter 8th grade, my junior high school burned. Just under 200 of my classmates and I, plus some of our teachers, were transferred to an eight-room wing of the newly-built, gigantic area high school, leaving behind some 500 other classmates. Did we bond? You bet. We had to. Did I interact with classmates I otherwise would never have even met? You bet. Did we fit in when we transferred to the high school with our other classmates? Yes again. With ease and with poise.

Who was it who said the definition of insanity is trying the same things over and over and expecting different results? I think it's time for the Chelmsford School System to try something different. I applaud those trying to make that happen.

Adding minutes to day will not educate better

I'm calling to respond to the Speak-Out! question regarding the

APPENDIX "C"

A DAY IN THE LIFE

CLASSROOM SCHEDULING AND DAILY LEARNING ACTIVITIES

ACADEMIC FOCUS

The focus of the charter school will be experiential and integrated learning environments. Unlike the classical approach of teaching 7-8 different subjects during prescribed time blocks, the charter school will use a different concept of time allocation. Generally speaking, classes will focus a significant portion of a day for a one to two week period on a "learning unit" to foster the development of critical thinking skills.

Each learning unit will focus on concept development as applied to a specific situation in order to promote higher order thinking skills. Each learning unit will assign a task to the entire class with a specific completion deadline. The class will be required to organize the task, break it into manageable steps, and form smaller groups which act cooperatively within themselves as well as with the other groups to complete the task. Cooperative learning will be essential to successful task completion.

In this learning environment, the students do the learning themselves and the teachers act as facilitators to direct the learning. Concepts will be learned experientially and the application of concepts will solidify the knowledge gained. Groups will determine their own scope of work and consequently, the information that is needed to complete the scope of work.

The teacher as facilitator concept permits the teacher to effectively integrate the learning experience for the students. Other teachers will have planning time when they are not the facilitators.

The focus on small groups will permit each group to have the use of a computer at all times. The experiential nature of this learning promotes and, in fact, encourages activity in the class. Field experiences, outside the class, will be encouraged to gather information pertinent to the completion of a given project.

At the conclusion of the project, the class progress will be evaluated as compared to predetermined standards of achievement. Evaluation of the content of the unit, the ability of students to understand and complete the task, and the student's evaluation all play an important role in the feedback mechanism which drives each unit to be changed after each presentation.

The activity required to complete the unit will allow students to funnel and use their energies inside the classroom as opposed to bottling them up. By addressing the socialization issues in the class, less energy will be expended outside the class in inappropriate activities.

The exact length and content of the learning units will be determined by the staff and board of directors.

The board recognizes the need to teach basic, or "core area" skills such as grammar, algebra, sentence structure, math and the like at this level. These "core area" skills will be taught along with and as part of the learning units where possible.

Some of the learning units that will be a part of a typical semester at the charter school include;

- 1) Drama unit focusing on a presentation of a student-developed play.
- 2) Science unit focusing on an ecosystem of a local lake.
- 3) Math unit on probability.
- 4) English unit on sentence structure, grammar, and/or writing.
- 5) Physical unit on balancing skills.

Two representative school days have been attached.

NON-ACADEMIC FOCUS

Family groups are an important part of the school socialization environment. These groups will consist of a small number of students and an adult. Family groups will meet at the beginning of each day to start the day on a positive, sharing theme where students and faculty can speak candidly among themselves. These groups will also be the basis of student problem solving and planning.

Physical education will be a part of the school learning experience, but will be taught in a non-traditional manner. Emphasis will be on team building and positive reinforcement with a focus on non traditional activities.

Lunch and recess time will be supervised activities and will be used to foster socialization skills.

One Monday as a seventh grader.

7:00 - 8:00 Daycare and study help as part of the school day.

8:00 - 8:25 Family group meeting: overview of the week to come at school. Discussion regarding citizen topic of the month: Strategies to included students in activities.

8:30 - 9:15 "Core area" Mathematics

9:20 - 11:15 "Learning unit" - Humanities Project: A 5 day drama unit. Students develop a plot for a play set in the second half of the 18th century to show their understanding of the process leading to the American Revolution. Causal loop diagrams help students to produce a coherent in-depth plot. Introduction to basic acting techniques occurs during this unit.

11:00 - 11:55 Lunch and recess period. Several supervised informal activities are available during this time: basketball, quiet reading, table tennis, conversation room and a variety of board games.

12:00 - 12:45 "Core area" - Language arts

12:50 - 2:25 "Learning unit" - Humanities Project: students begin to write scripts and lyrics and develop characters. Choices are made regarding the music and possible dance routines.

2:30 - 3:00 Family group meeting- Study skills; students plan for the week ahead as well as for tonight's homework and check in with teacher. Some students start to work on homework, some are reading, and the remaining students are getting help from the teacher with organization.

3:00 - 5:30 Extended day: a 45 minute recess with informal activities followed by a 60 minute study period. Students work on homework, get help from each other or an adult as needed, or read. Remaining time is spent on leisure activities.

Another day, another week as a seventh grader.

7:00 - 8:00 Daycare as part of the school day.

8:00 - 8:25 Exercise: Aerobic activities, balancing skills

8:30 - 9:15 "Core area" Language Arts

9:20 - 11:15 "Learning unit" - Interdisciplinary Project: Freeman Lake unit. This is a manmade and locally well-known lake. Students will be challenged to investigate the lake from different points of view and to form a coherent picture of the lake as a system. Possible areas of investigation are history, geography, recreation, water quality, impact of development on the lake, fish and wildlife, traffic impact, etc. After the whole group overview and brainstorming session students form small research groups.

11:00 - 11:55 Lunch and recess period.

12:00 - 12:45 "Core area" - Mathematics

12:50 - 2:25 "Interdisciplinary unit" Freeman Lake unit. Small groups are starting to do research on the history and geography of the lake. Map reading and map making skills are introduced as a useful tool.

2:30 - 3:00 School Assembly: Kick off event to help bring in food for a local open pantry for the needy.

3:00 - 5:30 Extended day.

g:\wnword\charter

APPENDIX "D"

JOB DESCRIPTIONS, CONTRACTS

SECTION I. PURPOSE

STATEMENT OF INTENT TO CONTRACT:

The Chelmsford Alliance for Education, Inc., P.O. Box 142, Chelmsford, MA 01824 (hereafter "Employer") agrees to employ:

_____ (hereafter "Employee"), at the Charter School and the Employee agrees to be employed by the Employer upon the conditions and terms set forth below.

SECTION II. JOB SPECIFICATIONS

POSITION: The Employee will fill the position of:

_____ and agrees to meet the qualifications and responsibilities of the Job Description for that position, attached hereto and incorporated herein.

TERM OF CONTRACT This contract shall begin on July 1, 1995 and end on June 30, 1996. July - August 1995 will be a training and planning period and will therefore not require full-time, on-site work. The school calendar will follow the Chelmsford Public School calendar.

WAGES: The Employer shall pay the Employee _____ in consideration for training and planning during July and August 1995, and thereafter \$_____ for the September - June 10-month school year, to be paid in 10 equal monthly installments in exchange for the Employee's compliance with the conditions of employment within this contract and the attached job description.

HOURS: Monday and Friday 7:15am - 2:00pm and Tuesday through Thursday 7:15am - 3:15pm. It is recognized that parent conferences, meetings, and special events will require the employee's presence at other times.

SICK/PERSONAL DAYS: Full-time employees shall receive ten (10) sick days with pay for the 10 month school year. The Employee shall notify the Administrator as soon as possible in the event of an absence due to illness. At the discretion of the Administrator, sick day time can be used as a personal day if scheduled in advance with the Administrator.

HEALTH BENEFITS: The Employer will pay 80% of designated medical insurance for full time employees.

ADDITIONAL SPECIFICATIONS: The Employer and Employee agree to the following additional job specifications and benefits:

CONTENTS

ORIGINAL ARTICLES
The Problem of the Medical Student in the United States
The Medical Student in the United States
The Medical Student in the United States

ORIGINAL ARTICLES
The Medical Student in the United States
The Medical Student in the United States
The Medical Student in the United States

DEPARTMENTS

ORIGINAL ARTICLES
The Medical Student in the United States
The Medical Student in the United States
The Medical Student in the United States

ORIGINAL ARTICLES
The Medical Student in the United States
The Medical Student in the United States
The Medical Student in the United States

ORIGINAL ARTICLES
The Medical Student in the United States
The Medical Student in the United States
The Medical Student in the United States

ORIGINAL ARTICLES
The Medical Student in the United States
The Medical Student in the United States
The Medical Student in the United States

ORIGINAL ARTICLES
The Medical Student in the United States
The Medical Student in the United States
The Medical Student in the United States

ORIGINAL ARTICLES
The Medical Student in the United States
The Medical Student in the United States
The Medical Student in the United States

ORIGINAL ARTICLES
The Medical Student in the United States
The Medical Student in the United States
The Medical Student in the United States

ORIGINAL ARTICLES
The Medical Student in the United States
The Medical Student in the United States
The Medical Student in the United States

ORGANIZATIONAL STRUCTURE: The Employee will be directly responsible to the Administrator. Due to the nature of the school curriculum and its goals and objectives, the Employee must recognize and support the teaching team unit. It is necessary and expected that all employees lend assistance to, and give positive support to all those in the organizational structure of the Employer.

DISCIPLINARY ACTION: The Employer will handle disciplinary action as follows:

1. The Administrator will verbally address the area of complaint or non-compliance with job requirements with the staff member.
2. If the complaint or non-compliance continues, the Administrator will issue a written warning and meet with the staff member to discuss areas of complaint or non-compliance with job requirements. The written warning and any employee response will be placed in the employee's file.
3. If the complaint or non-compliance still continues after these steps have been followed, the employee shall be suspended or terminated by the Administrator.
4. An employee who feels they have been unfairly disciplined or dismissed should follow the grievance procedure.

IMMEDIATE DISMISSAL: The Employer may immediately dismiss the employee for the following reasons:

- a. Gross in-subordination.
- b. Being under the influence of alcohol or illegal drugs while working.
- c. Conviction on a morals charge.

CONTRACT RELEASE: It is the intention of the Employer to enforce this contract through its end date in the interests of consistency for the children. Therefore, resignations prior to that end date are rarely considered. Employees should utilize the grievance procedure should they feel they are being unfairly held to their contract.

GRIEVANCE PROCEDURE: An Employee who feels that they have been dealt with unfairly should first discuss the situation with the Administrator. Should this be unsatisfactory to the Employee, then she/he may submit, in writing, the grievance to the Board of Trustees. The Board's decision is final.

SECTION IV. SIGNATURES

I am a U.S. citizen or lawfully admitted alien eligible for employment:
Yes _____ No _____ Employee's Initials _____

I agree that I have read, and understand the above contract and the attached job description. Employee's Initials _____

Signed:

EMPLOYEE

DATE

EMPLOYER- C.A.E. President

DATE

CHELMSFORD ALLIANCE FOR EDUCATION, INC.
Charter School

JOB DESCRIPTION : ADMINISTRATOR

INTRODUCTION: The Charter School is a public school grades 6 and 7 program conducted by the Chelmsford Alliance for Education, Inc., a non-profit organization. Organized under the Educational Reform Act, it has been granted a charter by the Commonwealth of Massachusetts. The school's objectives are to provide a learner-centered, hands-on, technologically-integrated environment which provides students with a frame of reference to make what they are learning relevant to the complex world in which they live. It will proactively plan for positive transitions in the academic, physical, social, and emotional realms so vital to middle school students through a supportive network of community resources, a strong home-school partnership, and a school day that revolves around the needs and interests of the students.

QUALIFICATIONS: The Administrator's qualifications will include Commonwealth of Massachusetts teacher certification at the middle school level, as well as successful experience in learner-centered and hands-on curriculum, integration of technology, cooperative learning and teaching, and in developing a strong home-school partnership. In addition, the administrator will possess demonstrated successful administrative, supervisory, and management skills. This staff member must also be receptive to acquiring and implementing new skills in systems dynamics, facilitator roles, and other concepts supporting of the Charter Middle School's curriculum and environment. Completion of a First Aid and CPR course is required.

Other significant qualifications are:

- A comprehensive knowledge of adolescent development.
- A nurturing, patient, mature, organized, calm manner able to deal with a variety of personalities and situations with children, staff, and parents.
- A working knowledge of learner-centered curriculum techniques.
- An ability to supervise and motivate staff in a team teaching approach.
- A sensitivity to parent issues and an ability to build a partnership for their child's education.
- A working knowledge of non-profit budget management.
- A working knowledge of behavior management for adolescents, including special needs and at-risk children.

THE UNIVERSITY OF CHICAGO
DEPARTMENT OF CHEMISTRY
RESEARCH REPORT NO. 1000

1. The first part of the report describes the experimental work carried out during the last year. The results of the experiments are given in the following table:

| Experiment | Result |
|---|--|
| 1. Measurement of the rate of reaction of A with B at 25°C. | Rate constant = 1.2×10^{-4} sec ⁻¹ |
| 2. Measurement of the rate of reaction of A with B at 35°C. | Rate constant = 2.5×10^{-4} sec ⁻¹ |
| 3. Measurement of the rate of reaction of A with B at 45°C. | Rate constant = 5.0×10^{-4} sec ⁻¹ |

2. The second part of the report describes the theoretical work carried out during the last year. The results of the theoretical work are given in the following table:

| Theoretical Work | Result |
|---|--|
| 1. Calculation of the rate constant for the reaction of A with B at 25°C. | Rate constant = 1.0×10^{-4} sec ⁻¹ |
| 2. Calculation of the rate constant for the reaction of A with B at 35°C. | Rate constant = 2.0×10^{-4} sec ⁻¹ |
| 3. Calculation of the rate constant for the reaction of A with B at 45°C. | Rate constant = 4.0×10^{-4} sec ⁻¹ |

3. The third part of the report describes the conclusions drawn from the experimental and theoretical work. The conclusions are given in the following table:

| Conclusions | Result |
|---|---|
| 1. The rate of reaction of A with B increases with temperature. | Rate constant increases with temperature. |
| 2. The rate of reaction of A with B is independent of the concentration of A. | Rate constant is independent of the concentration of A. |
| 3. The rate of reaction of A with B is independent of the concentration of B. | Rate constant is independent of the concentration of B. |

RESEARCH REPORT NO. 1000

UNDER THE GENERAL SUPERVISION OF THE BOARD OF TRUSTEES, THE ADMINISTRATOR IS RESPONSIBLE FOR THE OVERALL OPERATION OF THE SCHOOL. DUE TO THE SIZE OF THE SCHOOL, THE ADMINISTRATOR WILL ALSO TEACH PART-TIME. THE ADMINISTRATOR'S RESPONSIBILITIES INCLUDE THESE ASPECTS:

- 1.Design and create goals and objectives, within the stated school philosophy and policies, for the school to maintain and improve quality and excellence. Work with the Board of Trustees to form and implement policies and procedures to carry this out.
- 2.With the teaching team, create and implement a developmental program, environment and curriculum consistent with the stated goals and objectives of the school.
- 3.Plan and supervise, with teaching team, community participation opportunities to extend and reinforce curriculum goals and objectives.
- 4.Develop and support strong home-school partnerships.Maintain ongoing communication between school and home. Schedule and coordinate monthly parent/staff meetings. Coordinate Parent Participation program.
- 5.Work with assigned students to develop and support a personal education plan that both fits the needs of the student and speaks to the school's goals and objectives. Compile assessment portfolios, write narratives, and complete standardized testing required to monitor student progress.
- 6.Initiate the referral process where needed for at-risk students. Advocate for the student and offer support for the parent in this process. Supervise the development and implementation of IEPs within the school program or provide a smooth transition for children moving to other programs.
- 7.Administrate the budget, including preparing periodic reports, approving and making expenditures, keeping financial records, and making adjustments where necessary to keep the school fiscally sound. Make budget recommendations to the Board of Trustees.
- 8.Attend Board of Trustee meetings and prepare and present information requested.
- 9.Coordinate public relations and recruitment efforts.
- 10.Develop contacts with the community and represent the school where appropriate.
- 11.Work with the Board of Trustees to hire and train all staff.
- 12.Develop staffing patterns that are cost-effective and beneficial to the student's development.
- 13.Directly supervise, support, communicate with, and evaluate the teachers and administrative assistant.
- 14.Provide for ongoing curriculum and program evaluation and growth. Arrange for annual review.
- 15.Support conflict resolution in "family" groupings and handle issues that cannot be resolved in that forum. Administrate code of conduct.
- 16.Maintain records as needed by state law and school policies.

THE UNIVERSITY OF CHICAGO
DEPARTMENT OF THE HISTORY OF ARTS
AND ARCHITECTURE
1155 EAST 58TH STREET
CHICAGO, ILLINOIS 60637
TEL: 773-936-5000

THE UNIVERSITY OF CHICAGO
DEPARTMENT OF THE HISTORY OF ARTS
AND ARCHITECTURE
1155 EAST 58TH STREET
CHICAGO, ILLINOIS 60637
TEL: 773-936-5000

THE UNIVERSITY OF CHICAGO
DEPARTMENT OF THE HISTORY OF ARTS
AND ARCHITECTURE
1155 EAST 58TH STREET
CHICAGO, ILLINOIS 60637
TEL: 773-936-5000

THE UNIVERSITY OF CHICAGO
DEPARTMENT OF THE HISTORY OF ARTS
AND ARCHITECTURE
1155 EAST 58TH STREET
CHICAGO, ILLINOIS 60637
TEL: 773-936-5000

THE UNIVERSITY OF CHICAGO
DEPARTMENT OF THE HISTORY OF ARTS
AND ARCHITECTURE
1155 EAST 58TH STREET
CHICAGO, ILLINOIS 60637
TEL: 773-936-5000

17. Develop personal and professional growth plan with Board of Trustees and participate in supervisory conferences and evaluations with staff.
18. Participate in training as needed to further the school's goals and objectives. Continue professional development through attendance and completion of local conferences, workshops, seminars, and courses.
19. Maintain a clean, safe school environment.
20. Carry out all school policies and procedures.

CHELMSFORD ALLIANCE FOR EDUCATION, INC.
Charter School

JOB DESCRIPTION : TEACHER

INTRODUCTION: The Charter School is a public school grades 6 and 7 program conducted by the Chelmsford Alliance for Education, Inc., a non-profit organization. Organized under the Educational Reform Act, it has been granted a charter by the Commonwealth of Massachusetts. The school's objectives are to provide a learner-centered, hands-on, technologically-integrated environment which provides students with a frame of reference to make what they are learning relevant to the complex world in which they live. It will proactively plan for positive transitions in the academic, physical, social, and emotional realms so vital to middle school students through a supportive network of community resources, a strong home-school partnership, and a school day that revolves around the needs and interests of the students.

QUALIFICATIONS: The Teacher's qualifications will include Commonwealth of Massachusetts teacher certification at the middle school level, as well as successful experience in learner-centered and hands-on curriculum, integration of technology, cooperative learning and teaching, and in developing a strong home-school partnership. In addition, the teacher must be receptive to acquiring and implementing new skills in systems dynamics, facilitator roles, and other concepts supporting of the Charter Middle School's curriculum and environment. Completion of a First Aid and CPR course is required.

Other significant qualifications are:

- A comprehensive knowledge of adolescent development.
- A nurturing, patient, mature, organized, calm manner able to deal with a variety of personalities and situations with children, staff, and parents.
- A working knowledge of learner-centered curriculum techniques.
- An ability to work in a team teaching approach.
- A sensitivity to parent issues and an ability to build a partnership for their child's education.

UNDER THE GENERAL SUPERVISION OF THE ADMINISTRATOR, THE TEACHER IS RESPONSIBLE FOR THE OVERALL OPERATION OF THE CLASSROOM. THE TEACHER'S RESPONSIBILITIES INCLUDE THESE ASPECTS:

1. Create a developmental program, environment and curriculum consistent with the stated goals and objectives of the school.
2. Plan and implement, with teaching team, developmentally appropriate, interdisciplinary curriculum activities.

THE UNIVERSITY OF CHICAGO
DEPARTMENT OF CHEMISTRY
RESEARCH REPORT

The following report was prepared by the members of the Department of Chemistry, University of Chicago, during the period from January 1, 1944, to December 31, 1944. The work was supported by the National Science Foundation, the Office of Naval Research, and the Army Research Office. The work was carried out in the Department of Chemistry, University of Chicago, and the results are reported in the following papers:

1. The study of the reaction of carbon monoxide with nickel carbonyl, by J. H. Goldstein and J. H. Goldstein, *Journal of Chemical Physics*, 13, 261 (1945).

2. The study of the reaction of carbon monoxide with nickel carbonyl, by J. H. Goldstein and J. H. Goldstein, *Journal of Chemical Physics*, 13, 261 (1945).

3. The study of the reaction of carbon monoxide with nickel carbonyl, by J. H. Goldstein and J. H. Goldstein, *Journal of Chemical Physics*, 13, 261 (1945).

4. The study of the reaction of carbon monoxide with nickel carbonyl, by J. H. Goldstein and J. H. Goldstein, *Journal of Chemical Physics*, 13, 261 (1945).

3. Plan and supervise, with teaching team, community participation opportunities to extend and reinforce curriculum goals and objectives.
4. Develop and nurture a strong home-school partnership through regular conferences, attendance at monthly meetings, and other communication with parents.
5. Work with each student to develop and support a personal education plan that both fits the needs of the student and speaks to the school's goals and objectives. Assist in the development and implementation of official IEPs as needed.
6. Compile assessment portfolios, write narratives, and complete standardized testing required to monitor student progress.
7. Supervise teaching aides as assigned and participate in their evaluation and personal and professional growth planning.
8. Develop personal and professional growth plan with Administrator and participate in supervisory conferences and evaluations with Administrator. Assist in this process for other members of the teaching team, as well as evaluations of the school program.
9. Participate in training as needed to further the school's goals and objectives. Continue professional development through attendance and completion of local conferences, workshops, seminars, and courses.
10. Keep the classroom supplies and equipment clean, organized and well maintained. Notify the Administrator of supply and equipment needs. Maintain a clean, safe environment.
11. Carry out all school policies and procedures.

CHELMSFORD ALLIANCE FOR EDUCATION, INC.
Charter School

JOB DESCRIPTION : ADMINISTRATIVE ASSISTANT

INTRODUCTION: The Charter School is a public school grades 6 and 7 program conducted by the Chelmsford Alliance for Education, Inc., a non-profit organization. Organized under the Educational Reform Act, it has been granted a charter by the Commonwealth of Massachusetts. The school's objectives are to provide a learner-centered, hands-on, technologically-integrated environment which provides students with a frame of reference to make what they are learning relevant to the complex world in which they live. It will proactively plan for positive transitions in the academic, physical, social, and emotional realms so vital to middle school students through a supportive network of community resources, a strong home-school partnership, and a school day that revolves around the needs and interests of the students.

QUALIFICATIONS: The Administrative Assistant's qualifications will include successful experience in office management, organization and the ability to substitute in the classroom. Completion of a First Aid and CPR course is required.

Other significant qualifications are:

- A nurturing, patient, mature, organized, calm manner able to deal with a variety of personalities and situations with children, staff, and parents.
- A working knowledge of office technology and bookkeeping.
- An ability to handle a variety of tasks at the same time.
- A knowledge of adolescent development.

UNDER THE DIRECT SUPERVISION OF THE ADMINISTRATOR, THE ADMINISTRATIVE ASSISTANT IS RESPONSIBLE FOR THE OVERALL OPERATION OF THE SCHOOL OFFICE AND RECORDKEEPING FUNCTIONS. THE ADMINISTRATIVE ASSISTANT ALSO COORDINATES THE SCHOOL FIRST AID RESPONSE. THE ADMINISTRATIVE ASSISTANT'S RESPONSIBILITIES INCLUDE THESE ASPECTS:

1. Answer telephones and greet visitors to the school.
2. Organize and run the school office.
3. Perform bookkeeping duties as assigned by the Administrator.
4. Offer secretarial support to the school staff and Board of Trustees.
5. File and maintain records as directed.
6. Prepare and submit information for payroll.
7. Data entry and processing as assigned.
8. Handle petty cash.

THE UNIVERSITY OF CHICAGO
DEPARTMENT OF CHEMISTRY
RESEARCH REPORT NO. 100
JANUARY 1950

REPORT OF THE RESEARCH GROUP
ON THE CHEMISTRY OF
THE CARBON-14 ISOTOPE

BY
DR. ROBERT A. RICE
AND
DR. ROBERT A. RICE, JR.

CHICAGO, ILLINOIS

1. INTRODUCTION
The purpose of this report is to present the results of the research carried out by the Research Group on the Chemistry of the Carbon-14 Isotope during the year 1949. The work was supported by the National Science Foundation, Office of Naval Research, and the University of Chicago.

2. SUMMARY
The research was carried out in the Department of Chemistry, University of Chicago, under the direction of Dr. Robert A. Rice. The work was carried out by Dr. Robert A. Rice, Jr., and the results are presented in this report.

3. DETAILED DESCRIPTION OF THE WORK
The work was carried out in the Department of Chemistry, University of Chicago, under the direction of Dr. Robert A. Rice. The work was carried out by Dr. Robert A. Rice, Jr., and the results are presented in this report.

9. Coordinate the ordering of supplies with Administrator's approval.
10. Coordinate the school's primary first aid response and referral.
11. Substitute in classrooms, occasionally, as needed.
12. Develop personal and professional growth plan with Board of Trustees and participate in supervisory conferences and evaluations with staff.
13. Participate in training as needed to further the school's goals and objectives. Continue professional development through attendance and completion of local conferences, workshops, seminars, and courses.
14. Help maintain a clean, safe school environment.
15. Carry out all school policies and procedures.

THE UNIVERSITY OF CHICAGO
DEPARTMENT OF THE HISTORY OF ARTS
AND ARCHITECTURE
OFFICE OF THE CURATOR
OF THE MUSEUM OF ARTS
AND ARCHITECTURE
540 EAST 57TH STREET
CHICAGO, ILLINOIS 60637
TEL: 773-936-5000
FAX: 773-936-5001
WWW.MUSEUMOFARTS.ORG

CHELMSFORD ALLIANCE FOR EDUCATION, INC.
Charter School

JOB DESCRIPTION : TEACHING AIDE

INTRODUCTION: The Charter School is a public school grades 6 and 7 program conducted by the Chelmsford Alliance for Education, Inc., a non-profit organization. Organized under the Educational Reform Act, it has been granted a charter by the Commonwealth of Massachusetts. The school's objectives are to provide a learner-centered, hands-on, technologically-integrated environment which provides students with a frame of reference to make what they are learning relevant to the complex world in which they live. It will proactively plan for positive transitions in the academic, physical, social, and emotional realms so vital to middle school students through a supportive network of community resources, a strong home-school partnership, and a school day that revolves around the needs and interests of the students.

QUALIFICATIONS: The Teaching Aide's qualifications will include successful experience with middle school level students. In addition, the teaching aide must be receptive to acquiring and implementing new skills in supporting systems dynamics, facilitator roles, and other concepts supporting of the Charter School's curriculum and environment. Completion of a First Aid and CPR course is required.

Other significant qualifications are:

- A comprehensive knowledge of adolescent development.
- A nurturing, patient, mature, organized, calm manner able to deal with a variety of personalities and situations with children, staff, and parents.
- An ability to work in a team teaching approach.
- A sensitivity to parent issues and an ability to build a partnership for their child's education.
- Training or experience in learner-centered and hands-on curriculum, integration of technology, cooperative learning and teaching, and/or in working with special needs or at-risk students is a desirable asset.

UNDER THE DIRECT SUPERVISION OF THE TEACHER, THE TEACHING AIDE IS RESPONSIBLE FOR ASSISTING THE TEACHER IN THE OPERATION OF THE CLASSROOM. THE TEACHING AIDE'S RESPONSIBILITIES INCLUDE THESE ASPECTS:

1. Support the teacher's developmental program, environment and curriculum consistent with the stated goals and objectives of the school.

2. Help implement, with teaching team, developmentally appropriate, interdisciplinary curriculum activities. Ready curriculum materials as directed.
3. Supervise and work with individual students or groups of students as assigned by teacher.
4. Participate in home-school partnership as determined by teacher. Attend monthly meetings.
5. Help implement and support student personal education plans or IEPs as directed by the teacher.
6. Help compile assessment portfolios and records as assigned by teacher.
7. Develop personal and professional growth plan with Administrator and participate in supervisory conferences and evaluations with Administrator. Assist in this process for other members of the teaching team, as well as evaluations of the school program.
8. Participate in training as needed to further the school's goals and objectives. Continue professional development through attendance and completion of local conferences, workshops, seminars, and courses.
9. Keep the classroom supplies and equipment clean, organized and well maintained. Notify the teacher of classroom supply and equipment needs. Maintain a clean, safe environment.
10. Carry out all school policies and procedures.

CHELMSFORD ALLIANCE FOR EDUCATION, INC.
Charter Middle School

JOB DESCRIPTION : TEACHER

INTRODUCTION: The _____ Middle School is a public school grades 6 and 7 program conducted by the Chelmsford Alliance for Education, Inc., a non-profit organization. Organized under the Educational Reform Act, it has been granted a charter by the Commonwealth of Massachusetts. The school's objectives are to provide a learner-centered, hands-on, technologically-integrated environment which provides students with a frame of reference to make what they are learning relevant to the complex world in which they live. It will proactively plan for positive transitions in the academic, physical, social, and emotional realms so vital to middle school students through a supportive network of community resources, a strong home-school partnership, and a school day that revolves around the needs and interests of the students.

QUALIFICATIONS: The Teacher's qualifications will include Commonwealth of Massachusetts teacher certification at the middle school level, as well as successful experience in learner-centered and hands-on curriculum, integration of technology, cooperative learning and teaching, and in developing a strong home-school partnership. In addition, the teacher must be receptive to acquiring and implementing new skills in systems dynamics, facilitator roles, and other concepts supporting of the Charter Middle School's curriculum and environment. Completion of a First Aid and CPR course is required.

Other significant qualifications are:

- A comprehensive knowledge of adolescent development.
- A nurturing, patient, mature, organized, calm manner able to deal with a variety of personalities and situations with children, staff, and parents.
- A working knowledge of learner-centered curriculum techniques.
- An ability to work in a team teaching approach.
- A sensitivity to parent issues and an ability to build a partnership for their child's education.

UNDER THE SUPERVISION OF THE ADMINISTRATOR, THE TEACHER IS RESPONSIBLE FOR THE OVERALL OPERATION OF THE CLASSROOM. THE TEACHER'S RESPONSIBILITIES INCLUDE THESE ASPECTS:

1. Create a developmental program, environment and curriculum consistent with the stated goals and objectives of the school.
2. Plan and implement, with teaching team, developmentally appropriate, interdisciplinary curriculum activities.

**EMPLOYMENT CONTRACT BETWEEN
CHELMSFORD ALLIANCE FOR EDUCATION, INC. AND**

SECTION I. PURPOSE

STATEMENT OF INTENT TO CONTRACT:

The Chelmsford Alliance for Education, Inc., Chelmsford, MA 01824 (hereafter "Employer") agrees to employ:

_____ (hereafter "Employee"), at the _____ Middle School and the Employee agrees to be employed by the Employer upon the conditions and terms set forth below.

SECTION II. JOB SPECIFICATIONS

POSITION: The Employee will fill the position of:

_____ and agrees to meet the qualifications and responsibilities of the Job Description for that position, attached hereto and incorporated herein.

TERM OF CONTRACT This contract shall begin on July 1, 1995 and end on June 30, 1996. July - August 1995 will be a training and planning period and will therefore not require full-time, on-site work. The school calendar will follow the Chelmsford Public School calendar.

WAGES: The Employer shall pay the Employee _____ in consideration for training and planning during July and August 1995, and thereafter \$_____ for the September - June 10-month school year, to be paid in 10 equal monthly installments in exchange for the Employee's compliance with the conditions of employment within this contract and the attached job description.

HOURS: Monday and Friday 7:15am - 2:00pm and Tuesday through Thursday 7:15am - 3:15pm. It is recognized that parent conferences, meetings, and special events will require the employee's presence at other times.

SICK/PERSONAL DAYS: Full-time employees shall receive ten (10) sick days with pay for the 10 month school year. The Employee shall notify the Administrator as soon as possible in the event of an absence due to illness. At the discretion of the Administrator, sick day time can be used as a personal day if scheduled in advance with the Administrator.

HEALTH BENEFITS: The Employer will pay 80% of designated medical insurance for full time employees.

ADDITIONAL SPECIFICATIONS: The Employer and Employee agree to the following additional job specifications and benefits:

DATE

EMPLOYEE

EMPLOYER - C.A.E. President

THE
JOURNAL OF THE
ROYAL ANTHROPOLOGICAL INSTITUTE

Volume 100, Part 1, 1970
The Journal of the Royal Anthropological Institute
is published twice a year in May and November.
The subscription price of the Journal (which includes postage)
is £12.00 per annum in advance.

CONTENTS

| | |
|----------|----------|
| 1-10 | 1-10 |
| 11-20 | 11-20 |
| 21-30 | 21-30 |
| 31-40 | 31-40 |
| 41-50 | 41-50 |
| 51-60 | 51-60 |
| 61-70 | 61-70 |
| 71-80 | 71-80 |
| 81-90 | 81-90 |
| 91-100 | 91-100 |
| 101-110 | 101-110 |
| 111-120 | 111-120 |
| 121-130 | 121-130 |
| 131-140 | 131-140 |
| 141-150 | 141-150 |
| 151-160 | 151-160 |
| 161-170 | 161-170 |
| 171-180 | 171-180 |
| 181-190 | 181-190 |
| 191-200 | 191-200 |
| 201-210 | 201-210 |
| 211-220 | 211-220 |
| 221-230 | 221-230 |
| 231-240 | 231-240 |
| 241-250 | 241-250 |
| 251-260 | 251-260 |
| 261-270 | 261-270 |
| 271-280 | 271-280 |
| 281-290 | 281-290 |
| 291-300 | 291-300 |
| 301-310 | 301-310 |
| 311-320 | 311-320 |
| 321-330 | 321-330 |
| 331-340 | 331-340 |
| 341-350 | 341-350 |
| 351-360 | 351-360 |
| 361-370 | 361-370 |
| 371-380 | 371-380 |
| 381-390 | 381-390 |
| 391-400 | 391-400 |
| 401-410 | 401-410 |
| 411-420 | 411-420 |
| 421-430 | 421-430 |
| 431-440 | 431-440 |
| 441-450 | 441-450 |
| 451-460 | 451-460 |
| 461-470 | 461-470 |
| 471-480 | 471-480 |
| 481-490 | 481-490 |
| 491-500 | 491-500 |
| 501-510 | 501-510 |
| 511-520 | 511-520 |
| 521-530 | 521-530 |
| 531-540 | 531-540 |
| 541-550 | 541-550 |
| 551-560 | 551-560 |
| 561-570 | 561-570 |
| 571-580 | 571-580 |
| 581-590 | 581-590 |
| 591-600 | 591-600 |
| 601-610 | 601-610 |
| 611-620 | 611-620 |
| 621-630 | 621-630 |
| 631-640 | 631-640 |
| 641-650 | 641-650 |
| 651-660 | 651-660 |
| 661-670 | 661-670 |
| 671-680 | 671-680 |
| 681-690 | 681-690 |
| 691-700 | 691-700 |
| 701-710 | 701-710 |
| 711-720 | 711-720 |
| 721-730 | 721-730 |
| 731-740 | 731-740 |
| 741-750 | 741-750 |
| 751-760 | 751-760 |
| 761-770 | 761-770 |
| 771-780 | 771-780 |
| 781-790 | 781-790 |
| 791-800 | 791-800 |
| 801-810 | 801-810 |
| 811-820 | 811-820 |
| 821-830 | 821-830 |
| 831-840 | 831-840 |
| 841-850 | 841-850 |
| 851-860 | 851-860 |
| 861-870 | 861-870 |
| 871-880 | 871-880 |
| 881-890 | 881-890 |
| 891-900 | 891-900 |
| 901-910 | 901-910 |
| 911-920 | 911-920 |
| 921-930 | 921-930 |
| 931-940 | 931-940 |
| 941-950 | 941-950 |
| 951-960 | 951-960 |
| 961-970 | 961-970 |
| 971-980 | 971-980 |
| 981-990 | 981-990 |
| 991-1000 | 991-1000 |

APPENDIX "E"

BUDGET

Charter School Operating Budget

Five Year Projection

| DESCRIPTION | FY 1995 | FY 1996 | FY 1997 | FY 1998 | FY 1999 |
|--|----------|----------|----------|----------|----------|
| REVENUES | | | | | |
| Per Pupil Tuition Revenue | 425,040. | 656,700. | 676,368. | 696,696. | 717,552. |
| Student Entitlements | | | | | |
| Grants | | | | | |
| TOTAL REVENUES | | | | | |
| EXPENSES | | | | | |
| <i>Direct Student Costs:</i> | | | | | |
| Transportation | 0 | 0 | 0 | 0 | 0 |
| Supplies | 10,150.- | 25,950. | 21,300. | 21,050. | 16,450. |
| Computers and Materials | 20,000. | 16,000. | 20,000. | 13,000. | 13,500. |
| Field Study | 1,500. | 2,500. | 2,500. | 2,500. | 2,500. |
| Insurance Expense | 10,000. | 12,000. | 12,500. | 13,500. | 13,500. |
| Total Direct Student Costs | 41,650. | 56,450. | 56,300. | 50,050. | 45,950. |
| <i>Personnel: summer stipends</i> | 5,000.- | 10,000. | 10,000. | 10,000. | 10,000. |
| Principal/Executive | 50,000. | 60,000. | 62,000. | 65,000. | 68,000. |
| Teachers/consultants/physical | 157,000. | 273,500. | 284,500. | 297,550. | 312,000. |
| Clerical/Aides | 40,000. | 50,000. | 52,500. | 55,500. | 59,000. |
| Custodians | 0 | 0 | 0 | 0 | 0 |
| Benefits <small>workmen's comp. benefits, FICA, etc.</small> | 46,400. | 70,000. | 73,300. | 76,000. | 80,000. |
| Staff Development | 5,000. | 12,500. | 10,000. | 10,000. | 8,000. |
| Total Personnel | 303,400. | 476,000. | 492,300. | 514,100. | 537,000. |
| <i>Occupancy: inspection fees</i> | 500. | 500. | 400. | 400. | 400. |
| Rent | 18,000. | 27,000. | 29,000. | 30,000. | 30,000. |
| Mortgage | N/A | N/A | N/A | N/A | N/A |
| Maintenance | 5,200.- | 7,000. | 7,000. | 7,250. | 7,500. |
| Utilities (includes disposal) | 3,980. | 6,840. | 8,400. | 8,500. | 8,600. |
| Janitorial Supplies <small>(part of office supplies)</small> | | | | | |
| Total Occupancy | 27,680. | 41,340. | 44,800. | 46,150. | 46,500. |
| <i>Office:</i> | | | | | |
| Supplies | 2,050. | 3,550. | 3,600. | 3,600. | 4,000. |
| Equipment Rental/Maintenance | 500. | 500. | 500. | 500. | 500. |
| Telephone/Communications | 3,000. | 4,000. | 4,500. | 4,500. | 4,000. |
| Accounting & Payroll | 2,200. | 5,000. | 6,150. | 6,500. | 6,750. |
| Printing & Copying | 500. | 1,000. | 500. | 500. | 500. |
| Postage & Shipping | 1,000. | 2,000. | 2,000. | 2,000. | 2,000. |
| Total Office | 9,250. | 16,050. | 17,250. | 17,600. | 17,750. |
| <i>Other: substitutes</i> | 1,500. | 4,000. | 4,000. | 4,500. | 5,000. |
| Contingency Fund (10%) | 38,348. | 59,384. | 61,465. | 63,240. | 65,220. |
| TOTAL EXPENSES | 421,828. | 653,224. | 676,115. | 695,640. | 717,420. |
| EXCESS (or DEFICIENCY) | 3,212. | 3,476. | 253. | 1,056. | 132. |
| BEGINNING FUND BALANCE | 0 | 3,212. | 6,688. | 6,941. | 7,997. |
| ENDING FUND BALANCE | 3,212. | 6,688. | 6,941. | 7,997. | 8,129. |

See next page for more details

Budget

| | | YEAR 1 | YEAR 2 | YEAR 3 | YEAR 4 | YEAR 5 |
|--------------------------------|------------------------------------|--------------|--------------|--------------|--------------|--------------|
| Teachers, summer stipend | | \$5,000.00 | \$10,000.00 | \$10,000.00 | \$10,000.00 | \$10,000.00 |
| Training, summer | | \$2,500.00 | \$7,500.00 | \$5,000.00 | \$5,000.00 | \$3,000.00 |
| Rental | | \$3,000.00 | \$5,000.00 | \$5,000.00 | \$5,000.00 | \$5,000.00 |
| Bookkeeping | | \$200.00 | \$500.00 | \$750.00 | \$750.00 | \$750.00 |
| Insurance | | \$2,500.00 | \$4,000.00 | \$4,000.00 | \$4,500.00 | \$4,500.00 |
| Utilities | | \$300.00 | \$500.00 | \$500.00 | \$600.00 | \$600.00 |
| Brochures | | \$500.00 | \$500.00 | | | |
| Books | | \$5,000.00 | \$15,000.00 | \$10,000.00 | \$10,000.00 | \$10,000.00 |
| Postage | | \$500.00 | \$1,000.00 | \$1,000.00 | \$1,000.00 | \$1,000.00 |
| Classroom Materials | | | | | | |
| | Students desks | \$500.00 | \$250.00 | \$250.00 | \$250.00 | \$200.00 |
| | Teachers desks | \$200.00 | \$200.00 | \$200.00 | \$200.00 | \$250.00 |
| | Book cases | \$500.00 | \$1,000.00 | \$1,000.00 | \$1,000.00 | |
| | P.E. Supplies | \$200.00 | \$400.00 | \$750.00 | \$500.00 | \$500.00 |
| | Cassette deck | \$50.00 | \$100.00 | | \$100.00 | |
| | Science equip | \$3,000.00 | \$5,000.00 | \$5,000.00 | \$6,000.00 | \$3,000.00 |
| | Maps, etc. | \$200.00 | \$2,000.00 | \$2,500.00 | \$2,500.00 | \$2,000.00 |
| Office | | | | | | |
| | File Cabinets | \$50.00 | \$50.00 | \$100.00 | \$100.00 | |
| | Copier | \$500.00 | \$500.00 | \$500.00 | \$500.00 | |
| | Telephones | \$1,000.00 | \$500.00 | \$500.00 | \$500.00 | |
| | Computer | | | | | |
| | | \$80.00 | \$90.00 | \$100.00 | \$100.00 | \$100.00 |
| Disposal | | \$500.00 | \$1,000.00 | \$500.00 | \$500.00 | \$1,000.00 |
| VCR/Tapes/TV | | | \$500.00 | | | |
| Computer tables | | | | | | |
| Computer equipment | | \$20,000.00 | \$15,000.00 | \$20,000.00 | \$12,000.00 | \$12,000.00 |
| | SUBTOTAL | \$46,280.00 | \$70,590.00 | \$67,650.00 | \$61,100.00 | \$53,900.00 |
| Contract bookkeeping | | \$1,000.00 | \$1,500.00 | \$2,000.00 | \$2,000.00 | \$2,000.00 |
| Auditor | | \$1,000.00 | \$2,000.00 | \$2,000.00 | \$2,000.00 | \$2,000.00 |
| Review consultant | | \$500.00 | \$1,000.00 | \$1,500.00 | \$1,500.00 | \$2,000.00 |
| Trainers | | \$1,500.00 | \$5,000.00 | \$5,000.00 | \$5,000.00 | \$5,000.00 |
| Inspections/fees | | \$500.00 | \$500.00 | \$400.00 | \$400.00 | \$400.00 |
| Rent | | \$15,000.00 | \$22,000.00 | \$24,000.00 | \$25,000.00 | \$25,000.00 |
| Utilities | | | | | | |
| | Gas & electric | \$3,000.00 | \$5,500.00 | \$7,000.00 | \$7,000.00 | \$7,000.00 |
| | Telephones | \$2,000.00 | \$3,500.00 | \$4,000.00 | \$4,000.00 | \$4,000.00 |
| | Disposal | \$600.00 | \$750.00 | \$800.00 | \$800.00 | \$900.00 |
| On-line services | | | \$1,000.00 | \$1,000.00 | \$1,000.00 | \$1,500.00 |
| Insurance | | \$7,500.00 | \$8,000.00 | \$8,500.00 | \$9,000.00 | \$9,000.00 |
| Office supplies | | \$2,000.00 | \$4,000.00 | \$4,000.00 | \$4,000.00 | \$4,500.00 |
| Maintenance | | \$5,200.00 | \$7,000.00 | \$7,000.00 | \$7,250.00 | \$7,500.00 |
| Postage | | \$500.00 | \$1,000.00 | \$1,000.00 | \$1,000.00 | \$1,000.00 |
| Pay roll service | | \$1,000.00 | \$1,500.00 | \$1,500.00 | \$1,750.00 | \$2,000.00 |
| Buses | | \$1,000.00 | \$2,500.00 | \$2,500.00 | \$2,500.00 | \$2,500.00 |
| Physical Education Instruction | | \$5,000.00 | \$7,500.00 | \$8,000.00 | \$8,000.00 | \$8,500.00 |
| Special Education Consultant | | \$5,000.00 | \$15,000.00 | \$15,000.00 | \$16,000.00 | \$16,500.00 |
| Psychologist | | \$5,000.00 | \$10,000.00 | \$10,000.00 | \$11,000.00 | \$12,000.00 |
| Teachers | | | | | | |
| | Veterans | \$86,000.00 | \$140,000.00 | \$145,000.00 | \$150,800.00 | \$158,000.00 |
| | Recent Grade | \$56,000.00 | \$100,000.00 | \$105,000.00 | \$110,250.00 | \$115,000.00 |
| | Aides | \$16,000.00 | \$25,000.00 | \$26,250.00 | \$27,550.00 | \$29,000.00 |
| | One administrator | \$50,000.00 | \$60,000.00 | \$62,000.00 | \$65,000.00 | \$68,000.00 |
| | One assistant | \$24,000.00 | \$25,000.00 | \$26,250.00 | \$28,000.00 | \$30,000.00 |
| | Benefits, workmen's comp and taxes | \$46,400.00 | \$70,000.00 | \$73,300.00 | \$76,000.00 | \$80,000.00 |
| | Substitutes | \$1,500.00 | \$4,000.00 | \$4,000.00 | \$4,500.00 | \$5,000.00 |
| Contingency Fund (10%) | | \$38,348.00 | \$59,384.00 | \$61,465.00 | \$63,240.00 | \$65,220.00 |
| Total | | \$421,828.00 | \$653,224.00 | \$676,115.00 | \$695,640.00 | \$717,420.00 |

THE
JOURNAL
OF
THE
ROYAL
ANTHROPOLOGICAL
INSTITUTE

Volume 15
Part 1
1985

Editor
J. H. J. VAN DEN BERG
Editorial Board
J. H. J. VAN DEN BERG
J. H. J. VAN DEN BERG
J. H. J. VAN DEN BERG

Editorial Board
J. H. J. VAN DEN BERG
J. H. J. VAN DEN BERG
J. H. J. VAN DEN BERG
J. H. J. VAN DEN BERG

Editorial Board
J. H. J. VAN DEN BERG
J. H. J. VAN DEN BERG
J. H. J. VAN DEN BERG
J. H. J. VAN DEN BERG

Editorial Board
J. H. J. VAN DEN BERG
J. H. J. VAN DEN BERG
J. H. J. VAN DEN BERG
J. H. J. VAN DEN BERG

Editorial Board
J. H. J. VAN DEN BERG
J. H. J. VAN DEN BERG
J. H. J. VAN DEN BERG
J. H. J. VAN DEN BERG

Editorial Board
J. H. J. VAN DEN BERG
J. H. J. VAN DEN BERG
J. H. J. VAN DEN BERG
J. H. J. VAN DEN BERG

Volume 15
Part 1
1985

Volume 15
Part 1
1985

Start Up Budget

YEAR 1

| | |
|--------------------------|------------|
| Teachers, summer stipend | \$5,000.00 |
| Training, summer | \$2,500.00 |
| Rental | \$3,000.00 |
| Bookkeeping | \$200.00 |
| Insurance | \$2,500.00 |
| Utilities | \$300.00 |
| Brochures | \$500.00 |
| Books | \$5,000.00 |
| Postage | \$500.00 |
| Classroom Materials | |

| | |
|----------------|------------|
| Students desks | \$500.00 |
| Teachers desks | \$200.00 |
| Book cases | \$500.00 |
| P.E. Supplies | \$200.00 |
| Cassette deck | \$50.00 |
| Science equip | \$3,000.00 |
| Maps, etc. | \$200.00 |

Office

| | |
|---------------|------------|
| File Cabinets | \$50.00 |
| Copier | \$500.00 |
| Telephones | \$1,000.00 |
| Computer | |

| | |
|--------------------|-------------|
| Disposal | \$80.00 |
| VCR/Tapes/TV | \$500.00 |
| Computer tables | |
| Computer equipment | \$20,000.00 |

SUBTOTAL \$46,280.00

Handwritten Title

First paragraph of text, possibly a list or table of contents.

Second paragraph of text.

Third paragraph of text.

Fourth paragraph of text.

Fifth paragraph of text.

Sixth paragraph of text.

Seventh paragraph of text.

Eighth paragraph of text.

APPENDIX F

SYSTEMS DYNAMICS ARTICLES

APPENDIX F

SYSTEMS DYNAMICS
EXERCISES

System Dynamics and Learner-Centered-Learning in Kindergarten through 12th Grade Education

Jay W. Forrester
Germeshausen Professor Emeritus
and Senior Lecturer
Sloan School of Management
Massachusetts Institute of Technology
Cambridge, MA, 02139, USA
December 21, 1992

Abstract: Pre-college education is under attack for poorly serving the needs of society. Unless a superior concept for improving education emerges, public displeasure is apt to result in still more of what is already not working. But now, a fundamentally new and more effective approach to education is emerging from advances in system dynamics. System dynamics offers a framework for giving cohesion, meaning, and motivation to education at all levels from kindergarten upward. A second important ingredient, "learner-centered learning," imports to pre-college education the challenge and excitement of a research laboratory. Together, these two innovations harness the creativity, curiosity, and energy of young people. System dynamics allows reversing the traditional educational sequence in which deadening years of learning facts have preceded use of those facts by introducing synthesis (putting it all together) at an early stage in a student's experience. Such synthesis can be based on facts that even elementary school students already have gleaned from life. Learner-centered learning reverses the process of a teacher lecturing facts to resistant students. Learners have the opportunity to explore, gather information, and create unity out of their educational experiences. A "teacher" in the new setting acts as a guide and participating learner, rather than as an authoritarian source of all wisdom.

THE JOURNAL OF THE
ROYAL ANTHROPOLOGICAL INSTITUTE
OF GREAT BRITAIN AND IRELAND



Volume 100, Part 1, 1970
The Journal of the Royal Anthropological Institute of Great Britain and Ireland
is published twice a year, in May and November. It contains original research papers
and reviews of books and articles. The Journal is the principal journal of the
Institute and is read by anthropologists throughout the world. It is also
one of the leading journals in the field of human evolution and human
behaviour. The Journal is published by the Royal Anthropological Institute
of Great Britain and Ireland, which is a charitable organization dedicated
to the study of human evolution and human behaviour. The Institute
was founded in 1871 and has since that time been a leading center
for the study of human evolution and human behaviour. The Journal
is published by the Institute and is read by anthropologists throughout
the world. It is also one of the leading journals in the field of human
evolution and human behaviour. The Journal is published by the Royal
Anthropological Institute of Great Britain and Ireland, which is a charitable
organization dedicated to the study of human evolution and human behaviour.

Table of Contents

| | | |
|------|---|----|
| 1. | SOURCES OF EDUCATIONAL INEFFECTIVENESS | 5 |
| 2. | CORNERSTONES FOR A MORE EFFECTIVE EDUCATION | 7 |
| 2.1. | <i>Precursors of System Dynamics</i> | 7 |
| 2.2. | <i>System Dynamics in Pre-College Education</i> | 8 |
| 2.3. | <i>Learner-Centered Learning</i> | 10 |
| 3. | THE GORDON BROWN INFLUENCE | 10 |
| 4. | THE PRESENT STATUS | 13 |
| 5. | THE FUTURE | 17 |
| 6. | REFERENCES | 19 |

System Dynamics and Learner-Centered-Learning in Kindergarten through 12th Grade Education

by
Jay W. Forrester

Secondary education is under increasing attack for not preparing students to cope with modern life. Failures appear in the form of corporate executives who misjudge the complexities of growth and competition, government leaders who are at a loss to understand economic and political change, and publics that support inappropriate responses to immigration pressures, changing international conditions, rising unemployment, the drug culture, governmental reform, and inadequacies in education.

Growing criticism of education may direct attention to incorrect diagnoses and ineffective treatments. Weakness in education arises not so much from poor teachers as from inappropriateness of material that is being taught. Students are stuffed with facts without having a frame of reference for making those facts relevant to the complexities of life. Responses to educational deficiencies are apt to result in public demands for still more of what is causing the present educational failures. Pressures will increase for additional science, humanities, and social studies in an already overcrowded curriculum, a curriculum that fails to instill enthusiasm and a sense of relevance. Instead, an opportunity exists for moving toward a common foundation that pulls all fields of study into a more understandable unity.

1. Sources of Educational Ineffectiveness

Much current dissatisfaction with pre-college education arises from past inability to show how people interact with one another and with their physical environment, and to reveal causes for what students see happening. Because of its fragmentary nature, traditional education becomes less relevant as society becomes more complex, crowded, and tightly interconnected.

Education is compartmentalized into separate subjects that, in the real

Copyright © 1992
Jay W. Forrester

world, interact with one another. Social studies, physical science, biology, and other subjects are taught as if they were inherently different from one another, even though behavior in each rests on the same underlying concepts. For example, the dynamic structure that causes a pendulum to swing is the same as the core structure that causes employment and inventories to fluctuate in a product-distribution system and in economic business cycles. Humanities are taught without relating the dynamic sweep of history to similar behaviors on a shorter time scale that a student can experience in a week or a year.

High schools teach a curriculum from which students are expected to synthesize a perspective and framework for understanding their social and physical environments. But that framework is never explicitly taught. Students are expected to create a unity from the fragments of educational experiences, even though their teachers have seldom achieved that unity.

Missing from most education is direct treatment of the time dimension. What causes change from the past to the present and the present into the future? How do present decisions determine the future toward which we are moving? How are lessons of history to be interpreted to the present? Why are so many corporate, national, and personal decisions ineffective in achieving intended objectives? Conventional educational programs seldom reveal the answers. Answers to such questions about how things change through time lie in the dynamic behavior of social, personal, and physical systems. Dynamic behavior, common to all systems, can be taught as such. It can be understood.

Education has taught static snapshots of the real world. But the world's problems are dynamic. The human mind grasps pictures, maps, and static relationships in a wonderfully effective way. But in systems of interacting components that change through time, the human mind is a poor simulator of behavior. Mathematically speaking, even a simple social system can represent a tenth-order, highly nonlinear, differential equation. Mathematicians can not solve the general case for such an equation. No scientist, citizen, manager, or politician can reliably judge such complexity by intuition. Yet, even a junior high school student with a personal computer and coaching in computer simulation can advance remarkably far in understanding such systems.

Education faces the challenge of undoing and reversing much that people learn by observing simple dynamic situations. Experiences in everyday life deeply ingrain lessons that are deceptively misleading when one encounters more complex social systems (Forrester, 1971). For example, from burning one's fingers on a hot stove, one learns that cause and effect are closely related in both

time and space. Fingers are burned here and now when too close to the stove. Almost all understandable experiences reinforce the belief that causes are closely and obviously related to consequences. But in more complex systems, the cause of a difficulty is usually far distant in both time and space. The cause originated much earlier and arose from a different part of the system from where the symptoms appear.

To make matters even more misleading, a complex feedback system usually presents what we have come to expect, an apparent cause that lies close in time and space to the symptom. However, that apparent cause is usually a coincident symptom through which little leverage exists for producing improvement. Education does little to prepare students for succeeding when simple, understandable lessons so often point in exactly the wrong direction in the complex real world.

2. Cornerstones for a More Effective Education

Two mutually reinforcing developments now promise a learning process that can enhance breadth, depth, and insight in education. These two are system dynamics and learner-centered learning.

2.1. *Precursors of System Dynamics*

System dynamics evolved from prior work in feedback-control systems. The history of engineering servomechanisms reaches back several hundred years. Popular writing, religious literature, and the social sciences have grappled with the closed-loop circular nature of cause and effect for thousands of years (Richardson, 1991). In the 1920s and 1930s, understanding the dynamics of control systems accelerated. New theory evolved during development of electronic feedback amplifiers for transcontinental telephone systems at the Bell Telephone Laboratories and work at MIT on feedback controls for analog computers and military equipment.

After 1950, people became more aware that feedback control applies not only to engineering systems but also to all processes of change—biological, natural, environmental, and social.

The first of these is the fact that the
... of the ... of the ... of the ...
... of the ... of the ... of the ...
... of the ... of the ... of the ...

The second of these is the fact that the
... of the ... of the ... of the ...
... of the ... of the ... of the ...
... of the ... of the ... of the ...

The third of these is the fact that the
... of the ... of the ... of the ...
... of the ... of the ... of the ...
... of the ... of the ... of the ...

The fourth of these is the fact that the
... of the ... of the ... of the ...
... of the ... of the ... of the ...
... of the ... of the ... of the ...

The fifth of these is the fact that the
... of the ... of the ... of the ...
... of the ... of the ... of the ...
... of the ... of the ... of the ...

2.2. *System Dynamics in Pre-College Education*

During the last 30 years, those in the profession of system dynamics have been building a more effective basis than previously existed for understanding change and complexity. The field rests on three foundations:

1. Growing knowledge of how feedback loops, containing information flows, decision making, and action, control change in all systems. Feedback processes determine stability, goal seeking, stagnation, decline, and growth. Feedback systems surround us in everything we do. A feedback process exists when action affects the condition of a system and that changed condition affects future action. Human interactions, home life, politics, management processes, environmental changes, and biological activity all operate on the basis of feedback loops that connect action to result to future action.
2. Digital computers, now primarily personal computers, to simulate the behavior of systems that are too complex to attack with conventional mathematics, verbal descriptions, or graphical methods. High school students, using today's computers, can deal with concepts and dynamic behavior that only a few years ago were restricted to work in advanced research laboratories. Excellent user-friendly software is now available (High Performance Systems, 1990; Pugh, 1986).¹
3. Realization that most of the world's knowledge about dynamic structures resides in people's heads. The social sciences have relied too much on measured data. As a consequence, academic studies have failed to make adequate use of the data base on which the world runs—the information gained from living experience, apprenticeship, and participation. Students, even as early as kindergarten, already have a vast amount of operating information about individuals, families, communities, and schools from which they can learn about social, business, economic, and environmental behavior.

The system dynamics approach has been successfully applied to behavior in corporations, internal medicine, fisheries, psychiatry, energy supply and pricing, economic behavior, urban growth and decay, environmental stresses, population growth and aging, training of managers, and education of primary and secondary school students.

¹ For most work at the pre-college level, STELLA™ on Macintosh computers is easiest to use. It includes an excellent manual with learning exercises and an introduction to the philosophy of system dynamics. Some other system dynamics software packages are being developed with special attention to use in secondary schools. For more advanced professional use, software exists for system dynamics modeling, such as DYNAMO™ from Pugh-Roberts and Vensim™ from Ventana Systems.

THE HISTORY OF THE UNITED STATES

The history of the United States is a story of a people who have grown from a small colony of settlers to a great nation. It is a story of the struggles and triumphs of a people who have built a nation of freedom and justice.

The first settlers came to the New World in search of a better life. They found a land of opportunity and a chance to build a new society. They were the Pilgrims, the Puritans, and the other early settlers who laid the foundation for the United States.

The early years of the United States were marked by a series of wars and conflicts. The American Revolution was a struggle for independence from British rule. The War of 1812 was a fight to establish the nation's sovereignty.

The Civil War was a conflict that shaped the nation's future. It was a struggle over the issue of slavery, which had been a part of the American dream from the beginning. The war ended slavery and paved the way for a more unified and just nation.

The United States has come a long way since its founding. It has grown into a great nation, a leader in the world. It has fought for freedom and justice, and it has built a nation that is a source of pride and inspiration for all.

The history of the United States is a story of a people who have built a nation of freedom and justice. It is a story of the struggles and triumphs of a people who have built a nation that is a source of pride and inspiration for all.

Nancy Roberts first demonstrated system dynamics as an organizing framework at the fifth and sixth grade levels (Roberts, 1975). Her work (Roberts, 1978) showed the advantage of reversing the traditional educational sequence that normally progresses through five steps:

- 1) learning facts
- 2) comprehending meaning
- 3) applying facts to generalizations
- 4) analyzing to break material into constituent parts
- 5) synthesizing to assemble parts into a whole.

Most students never reach that fifth step of synthesis. But, synthesis—putting it all together—should be placed at the beginning of the educational sequence. By the time students are in school they already possess a wealth of observations about family, interpersonal relations, community, and school. They are ready for a framework into which the facts can be fitted. Unless that framework exists, teaching still more facts loses significance.

In his penetrating discussion of the learning process, Bruner states, "the most basic thing that can be said about human memory... is that unless detail is placed into a structured pattern, it is rapidly forgotten" (Bruner, 1963, p. 24). For most purposes, such a structure is inadequate if it is only a static framework. The structure should show the dynamic significance of the detail—how the details are connected, how they influence one another, and how past behavior and future outcomes arise from decision-making policies and their interconnections.

System dynamics can provide that dynamic framework to give meaning to detailed facts. Such a dynamic framework provides a common foundation beneath mathematics, physical science, social studies, biology, history, and even literature.

In spite of the potential power of system dynamics, it could well be ineffective if introduced alone into a traditional educational setting in which students passively receive lectures. System dynamics can not be acquired as a spectator sport any more than one can become a good basketball player by merely watching games. Active participation instills the dynamic paradigm. Hands-on involvement is essential to internalizing the ideas and establishing them in one's own mental models. But traditional class rooms lack the intense involvement so essential for deep learning.

2.3. *Learner-Centered Learning*

Those who have experienced the excitement and intensity of a research laboratory know the involvement accompanying new discoveries. Why should not students in their formative years experience similar exhilaration from exploring new challenges? That sense of challenge exists when a classroom operates in a "learner-centered-learning" mode.

Learner-centered learning, is a term I first encountered from Mrs. Kenneth Hayden of Ideals Associated.² It substantially alters the role of a teacher. A teacher is no longer a dispenser of knowledge addressed to students as passive receptors. Instead, where small teams of students explore and work together and help one another, a "teacher" becomes a colleague and participating learner. Teachers set directions and introduce opportunities. Teachers act as guides and resource persons, not as authoritarian figures dictating each step of the educational process. The relationship is more like being a thesis adviser than a lecturer.

3. The Gordon Brown Influence

The thread leading to system dynamics started when I was introduced to feedback systems in the early 1940s by Gordon S. Brown, then director of the MIT Servomechanisms Laboratory. Later, Brown became head of the MIT Electrical Engineering Department and then Dean of Engineering before retiring in 1973. In the late 1980s, he completed the circle he had originally launched by picking up system dynamics and introducing it into the Orange Grove Junior High School in Tucson, Arizona (Brown, 1992).

Friends of Brown have established the "Gordon Stanley Brown Fund," administered through the System Dynamics Society. The fund will support released time and summer time for teachers who have applied system dynamics, so that they can put into transmittable and usable form the materials and methods that can help others. It will also support communication of experiences that did not meet expectations so that others can be forewarned of difficulties and paths to be avoided.

² Ideals Associated, 2570 Avenida de Maria, Tucson, AZ 85718 USA is a small foundation that for two decades has fostered an approach to learning that enlists students themselves in an active participation that contributes to the momentum of the educational process.

Brown describes his role as the "citizen champion" engaged in drawing all participants in the school system together in their search for a new kind of education:

"the use of computers in the classroom (not in a computer lab) has, for us in Tucson, resulted in a very unique learning environment... (students) learn what they need to know as the teacher guides them in conducting a simulation in class. They work in groups, two or three to a computer—certainly not one per computer—and thereby help one another. Dr. Barry Richmond says that this situation, in effect, multiplies the number of teachers by the number of students. Before doing a simulation the students spend several class periods gathering information about the topic; they take notes during lectures, learn about a library and read references, and, working as a group, plan the simulation. By working this way Draper's students do not merely try to remember the material for a test but actually have to use it in a project simulating real life situations. This has led us to identify a new teaching paradigm which we define as SYSTEM THINKING with LEARNER-CENTERED LEARNING." (Brown, 1990)

Gordon Brown started by loaning the STELLA software for a weekend to Frank Draper, an 8th grade biology teacher. Draper returned with the comment, "This is what I have always been looking for, I just did not know what it might be." At first, Draper expected to use system dynamics and computer simulation in one or two classes during a term. Then he found they were becoming a part of every class. With so much time devoted to system dynamics and simulation, he feared he would not have time to cover all the required biology. But, two thirds of the way through the term, Draper found he had completed all the usual biology content. He had a third of the term left for new material. The more rapid pace had resulted from the way biology had become more integrated and from the greater student involvement resulting from the systems viewpoint. Also, much credit goes to the "learner-centered learning" organization of student cooperative study teams within the classroom. To quote Draper, "There is a free lunch." He writes of his classroom experience:

"Since October 1988 our classrooms have undergone an amazing transformation. Not only are we covering more material than just the required curriculum, but we are covering it faster (we will be through with the year's curriculum this week and will have to add more material to our curriculum for the remaining 5 weeks) and the students are learning more useful material than ever before. 'Facts' are now anchored to meaning through the dynamic relationships they have with each other. In our classroom students shift from being passive receptacles to being active learners. They are not taught about science per se, but learn how to acquire and use knowledge (scientific and otherwise). Our jobs have shifted from dispensers of information to producers of environments that allow students to learn as much as possible.

"We now see students come early to class (even early to school), stay after

the bell rings, work through lunch and work at home voluntarily (with no assignment given). When we work on a systems project—even when the students are working on the book research leading up to system work—there are essentially no motivation/discipline problems in our classrooms." (Draper, 1989)

A dynamic framework can even organize the study of literature (Hopkins, 1992). Classes taught by Pamela Hopkins are from an underprivileged section of the city and many had been labeled as slow learners. Simulation opened the door to a new way of capturing student interest and involvement. In a seminar for teachers taught by Barry Richmond and Steve Peterson of High Performance Systems, she participated in developing a model of psychological dynamics in Shakespeare's *Hamlet*:

"(when we used) a STELLA model which analyzed the motivation of Shakespeare's Hamlet to avenge the death of his father in HAMLET... The students were engrossed throughout the process... The amazing thing was that the discussion was completely student dominated. For the first time in the semester, I was not the focal point of the class. I did not have to filter the information from one student back to the rest of the class. They were talking directly to each other about the plot events and about the human responses being stimulated. They talked to each other about how they would have reacted and how the normal person would react. They discussed how previous events and specific personality characteristics would affect the response to each piece of news, and they strove for precision in the values they assigned for the power of each event. My function became that of listening to their viewpoints and entering their decisions into the computer. It was wonderful! It was as though the use of precise numbers to talk about psychological motives and human responses had given them power, had given them a system to communicate with. It had given them something they could handle, something that turned thin air into solid ground. They were directed and in control of learning, instead of my having to force them to keep their attention on the task." (Hopkins, 1990)

Several months after the experience related in the Hopkins article, I received a letter from Louise Hayden, director of Ideals Associated:

"Pam and I are so pleased and surprised at the ongoing involvement and depth of interest the high school students in her workshop of last June are showing. They are meeting with her weekly after school, eager to learn more about system dynamics and to use their advances to help younger students learn. They are arousing considerable teacher interest as they try to use causal loops in all their classrooms. Information is flowing upward—and from students who varied in achievement from high to very low.

We attribute the enthusiasm and commitment to their sense of the potential of systems thinking, and to the feelings of self-worth from being regarded as educational consultants. It is their first experience in learner-centered learning. This

may well be the first time they have considered themselves a responsible part of the social system." (Hayden, 1990)

Many people assume that only the "best" students can adapt to the style of education here suggested. But who are the best students? Results so far indicate no correlation between students who do well in this program and how they had been previously labeled as fast or slow learners. Some of the so-called slow learners find traditional education lacks relevance. They are not challenged. In a different setting they come into their own and become leaders. Some of the students previously identified as best are strong on repeating facts in quizzes but lack an ability to synthesize and to see the meaning of their facts. Past academic record seems not to predict how students respond to this new program.

4. The Present Status

System dynamics is developing rapidly, but does not yet have widespread public visibility. The international System Dynamics Society was formed in 1985. Membership has grown to some 300. Annual international meetings have been held for fifteen years in locations as widely spread as Norway, Colorado, Spain, China, California, Germany, and Thailand. System dynamics books and papers are regularly translated into many languages including Russian, Japanese, and Chinese.

Six hundred people attended a recent conference on systems thinking organized by Pegasus Communications.³

After 30 years of development, several dozen books present the theory, concepts, and applications of system dynamics. Some have exerted surprising public impact (Forrester, 1969; Forrester, 1971). *The Limits to Growth* book (Meadows, et al., 1972), showing interplay among population, industrialization, hunger, and pollution, has been translated into some 30 languages and has sold over three million copies. Such wide-spread readership of books based on computer modeling testifies to a public longing to understand how present actions influence the future. *Limits to Growth* has been recently updated as *Beyond the Limits*. (Meadows, et al., 1992)

Early leaders in system dynamics were educated at M.I.T. But competence is now appearing in many places. Talent exists on which to build a new kind of education, even though system dynamics is so broadly applicable throughout

³ Pegasus Communications, 1696 Massachusetts Ave., Cambridge, MA 02138, publisher of the monthly *The Systems Thinker*.

physical, social, biological, and political systems that the present small number of experts are thinly dispersed over a wide spectrum of activities.

System dynamics is now becoming well established in some thirty junior and senior high schools. Several hundred schools have started exploratory activity.

Part of the educational emphasis focuses on "generic structures." A rather small number of relatively simple structures appear repeatedly in different businesses, professions, and real-life settings. Students can transfer insights from one setting to another. For example, one of Draper's eighth grade students grew bacteria in a culture dish, then looked at the same pattern of environmentally limited growth through computer simulation. From the computer, the student looked up and observed, "This is the world population problem, isn't it?" Such transfer of insights from one setting to another will help to break down barriers between disciplines. It means that learning in one field becomes applicable to other fields.

There is now promise of reversing the trend of the last century toward ever greater fragmentation in education. There is real hope of moving back toward the "Renaissance man" idea of a common teachable core of broadly applicable concepts. We can now visualize an integrated, systemic, educational process that is more efficient, more appropriate to a world of increasing complexity, and more supportive of unity in life.

Several high schools, curriculum-development projects, and colleges are using a system dynamics core to build study units in mathematics, science, social studies, and history. But such programs have not yet reached the point of becoming fully integrated educational structures.

The most advanced United States experiment in bringing system dynamics and learner-centered learning together into a more powerful educational environment appears to be in the Catalina Foothills School District of Tucson, Arizona. In that community the necessary building blocks for successful educational innovation have come together. Progress in that school system rests on:

- 1) fundamental new concepts of education,
- 2) a receptive community,

- 3) talented teachers who are willing to try unfamiliar ideas and who are at ease in the nonauthoritarian environment of learner-centered learning,
- 4) a school administration that is applying a systems viewpoint in seeking total quality, mutual understanding, and continuous improvement,
- 5) a supportive school board,
- 6) and a "citizen champion" who, without a personal vested interest in the outcome except for a desire to facilitate improvement in education, has helped by inspiring teachers, finding funding, arranging for computers, and, above all, facilitating convergence of political differences in the community.

The Catalina Foothills district did not have its own high school. Students went into the Greater Tucson system. After seeing the impact on several hundred students of the new educational philosophy embedded in the Orange Grove junior high school, parents became reluctant to have children revert to a traditional high school. The District in 1990 voted a \$30 million bond issue to create a high school in the educational pattern that had been pioneered in the junior high school.

In March 1992 a "Systems Thinking in Education Conference" was held in Tucson. Two hundred people attended six plenary sessions and seven sequences of parallel sessions. Enthusiasm was high with reports of systems activity from fourth to twelfth grades.

The Educational Testing Service has established the Systems Thinking and Curriculum Innovation Network Project (STACI) involving about a dozen schools to explore the use of system dynamics in classrooms.⁴

"The approach consists of three separate but interdependent components: system dynamics, the theoretical perspective; STELLA, a simulation modeling software package; and the Macintosh computer.... The STACI Project is an implementation and research effort that examines the cognitive and curricular impact of using the systems thinking approach in pre-college instruction.... Because it is critical for teachers to be able to seek assistance easily from experts and other teachers, an electronic mail network using AppleLink has been established among the schools... the project focuses on the examination of cognitive and learning outcomes.... the systems approach is being used in

⁴ Ellen B. Mandinach and Hugh F. Cline, Educational Testing Service, Princeton, NJ 08541, USA.

courses that reach a range of students. Contrary to initial beliefs, the perspective can be used to facilitate instruction of low- as well as high-ability students.... from initial results, the use of the systems approach for less able learners seems to be yielding promising outcomes." (Mandinach and Cline, 1989)

Some other countries are moving ahead rapidly in using system dynamics as a foundation for an educational system below the college level. The Scandinavian countries are working together. Davidsen⁵ describes their guiding philosophy:

"System dynamics is a method, used in the study of complex, dynamic systems. Its pedagogical qualities are under investigation in several countries.... our final goal is to provide our students with an effective way of thinking about complex, dynamic systems. Thus we want to change their cognitive style. Far beyond establishing a basis of values, attitudes, and factual knowledge, our schools significantly influence the way each one of our students will be thinking.... we encourage our students to become critical users of models and to question assumptions underlying models, used for professional and political purposes. They should gain respect for real life complexity and variety and question simple solutions to complex problems.... In Norwegian and Nordic schools, we have chosen to utilize the conceptual framework offered by system dynamics for our educational purposes... When we have established an understanding of the basic dynamic processes, we are ready to address ourselves to reality. Then we will have to tackle systems of far greater complexity, typically characterized by feedback, delays, nonlinearities, and noise.... (pursuing) causal chains until they close upon each other, leads us to a multi-disciplinary approach.... Academic boundaries no longer constitute the boundaries of our imagination or our investigation. Historic and economic considerations are merged with physics and chemistry in our study of ecological issues." (Davidsen, 1990)

I have received a German book detailing their experimental use of system dynamics and the STELLA software for teaching high school physics (Bethge and Schecker, 1992).⁶

Several schools are making good progress with system dynamics and learner-centered learning below the level of junior high school students. In the public schools of Ridgewood, New Jersey, Timothy Lucas and Rich Langheim have been focusing on first through fifth grades.

⁵ Pål I. Davidsen, Department of Information Science, University of Bergen, Thormøhlensgt 55, N-5006 Bergen, NORWAY.

⁶ Horst Schecker, Institute of Physics Education, Department of Physics, University of Bremen, Postbox 330440, D-2800 Bremen 33, GERMANY.

5. The Future

Over the next several decades, an improved kind of education can evolve. The growing frustrations in corporate, economic, social, political, and international organizations demonstrate the need for better understanding. The basis now exists for a far more effective educational process. But a vast amount of work remains to build on the present foundation. Adequate educational materials are yet to be developed. One book was written especially for high schools (Roberts, et al., 1983). Although not written specifically for pre-college use, other introductory system dynamics books are available (Forrester, 1961; Forrester, 1968; Forrester, 1969; Forrester, 1975; Goodman, 1974; Richardson and Pugh, 1981). Nevertheless, the published material does not yet adequately convey the background, simulation models, related teacher-support materials, and guidance on teaching methods. Much material already exists in places ranging from files at MIT to work of teachers who are pioneering in systems thinking and learner-centered learning. But most existing materials are not now widely accessible.

No network has existed before 1992 for interchanging information among all interested innovators in pre-college education. But that missing link is now being remedied by a new office, the Creative Learning Exchange,⁷ established by John R. Bemis, to receive, print, and distribute system dynamics educational materials. That office will maintain communications among schools, encourage training seminars for teachers, advise teachers in preparing new materials for wider dissemination, and assist in maintaining the integrity and practicality of the system dynamics content of emerging curricula.

A group of students in the MIT Undergraduate Research Opportunities Program are working with me to develop educational materials for use in schools. They are working with teachers in the Cambridge Rindge and Latin High School to test materials and acquire experience in the real world of teachers and classrooms. In a current project they are creating a "Road Maps" agenda for self study in systems dynamics as applied to education. The agenda is a guide to using available published material, which will be supplemented by papers written by the students and some selections from more than 4000 memoranda in the files of the MIT System Dynamics Group. The material from this "System Dynamics in Education Project" will be distributed through the Creative Learning Exchange. This project is creating examples of quality systems work to help

⁷ Ms. Lees Stuntz, Executive Director, Creative Learning Exchange, 1 Keefe Road, Acton, MA 01720, USA, tel: 508-287-0070, fax: 508-287-0080

establish standards for educational programs. It is not the intention to create entire unified courses of study, but rather to generate examples that teachers can use in a wide range of educational settings.

Many private individuals are moving ahead to provide financial assistance to the development of systems education, rather than waiting for public political organizations to innovate. Private support can operate with a freedom and a clarity of purpose that is seldom possible with the bureaucratic processes of government and large foundations.

I believe that the immediate goal is to reach a point where at least twenty schools have been unambiguously successful and have achieved self-sustaining momentum. Thus far, many schools are making good progress but are still relying on outside guidance to assist when barriers are encountered. Some are beginning to emerge from such dependence on external assistance, but there are not yet sufficient examples of on-going, independent successes to over-shadow failures that are almost certain to occur. Preliminary results from system dynamics in primary and secondary schools show such promise that too many schools without the ingredients for success may begin, then fail. As a result, systems education might be discredited unless sufficient successes have been demonstrated to sustain the hope and promise of a more effective education.

The politics and processes of moving from a traditional school to a radically different style of education must be better understood. No one yet knows what percentage of present teachers can make the transition from traditional teacher-dominated classrooms to the free-wheeling, research atmosphere of a learner-centered classroom. To some teachers, the transition is threatening. Little is known about how to evaluate students coming out of this different kind of education. Standardized evaluation probably is not desirable or possible in a program that emphasizes individual development and diversity.

Creating a new kind of education will take substantial time. Planning and funding should provide for long-run continuity based on step-by step progress. Funding will be needed for developing materials, retraining teachers, and launching demonstration schools.

A core of system dynamics experts should monitor progress and continually nudge the activities toward higher quality. There are many ways in which erroneous concepts can creep into such an education. If such fallacies go uncorrected, systems education may be perceived as superficial and unsound and lead to negative backlash. Contributions are essential from experienced teachers,

1. The first part of the report deals with the general situation of the country and the results of the survey.

2. The second part of the report deals with the results of the survey in the different districts.

3. The third part of the report deals with the results of the survey in the different districts.

4. The fourth part of the report deals with the results of the survey in the different districts.

5. The fifth part of the report deals with the results of the survey in the different districts.

6. The sixth part of the report deals with the results of the survey in the different districts.

who understand the problems and opportunities in class rooms, and can translate ideas into effective teaching materials. "Citizen champions" can serve an important role to draw together teachers, school administrators, school boards, parents, concerned public, and governmental officials. Such influential groups are beginning to coalesce around the combined concepts of system dynamics and learner-centered learning.

6. References

- Bethge, Thomas, and Horst Schecker, 1992. *Materialien zur Modellbildung und Simulation im Physikunterricht*, Bremen, Germany: Institut für Didaktik der Physik, Universität Bremen. 238 pp.
- Brown, Gordon S., 1990. *The Genesis of the System Thinking Program at the Orange Grove Middle School, Tucson, Arizona*. Personal report. 6301 N. Calle de Adelita, Tucson, AZ 85718: March 1. 8 pp.
- Brown, Gordon S., 1992. "Improving Education in Public Schools: Innovative Teachers to the Rescue." *System Dynamics Review*, Vol. 8, No. 1, pp. 83-89.
- Bruner, Jerome S., 1963. *The Process of Education*, New York: Vintage Books.
- Davidson, Pål L., 1990. "System Dynamics, a Pedagogical Approach to the Teaching of Complex, Dynamic Systems by Means of Simulation (draft copy)." In *for EURIT 90, The European Conference on Technology and Education*, pp. 12,
- Draper, Frank, 1989. *Letter to Jay Forrester*. Personal communication, Orange Grove Junior High School, 1911 E. Orange Grove Rd., Tucson, AZ 85718. May 2.
- Forrester, Jay W., 1961. *Industrial Dynamics*, Cambridge, MA: Productivity Press. 464 pp.
- Forrester, Jay W., 1968. *Principles of Systems*, (2nd ed.). Cambridge, MA: Productivity Press. 391 pp.
- Forrester, Jay W., 1969. *Urban Dynamics*, Cambridge, MA: Productivity Press. 285 pp.
- Forrester, Jay W., 1971. "Counterintuitive Behavior of Social Systems." *Technology Review*, Vol. 73, No. 3, pp. 53-68. Also appears as Chapter 14, pages 211-244, in the author's *Collected Papers* 1975; and as Chapter 1, pp. 3-30, in *Toward Global Equilibrium: Collected Papers*, 1973, Dennis L. Meadows, ed., both from Cambridge MA: Productivity Press.
- Forrester, Jay W., 1971. *World Dynamics*, (1973 second ed.). Cambridge, MA: Productivity Press. 144 pp. Second edition has an added chapter on physical vs. social limits.
- Forrester, Jay W., 1975. *Collected Papers of Jay W. Forrester*, Cambridge, MA: Productivity Press. 284 pp.
- Goodman, Michael R., 1974. *Study Notes in System Dynamics*, Cambridge, MA: Productivity Press. 388 pp.
- Hayden, Louise, 1990. *Letter of October 2, 1990 to Jay Forrester*. Personal communication, 1 pp.

The following is a list of the names of the persons who have been elected to the office of the President of the United States, and the names of the persons who have been elected to the office of the Vice President of the United States, in the year 1900.

President

William McKinley

Vice President

Charles Fairbanks

Secretary of State

John Hay

Attorney General

Wm. H. Taft

Chief Justice

John Marshall Harlan

Associate Justice

Samuel J. McKim

President of the United States

- High Performance Systems, 1990. *STELLA II Users Guide*. Macintosh. 45 Lyme Road, Hanover, NH: High Performance Systems.
- Hopkins, Pamela Lee, 1990. *Classroom Implementation of STELLA to Illustrate Hamlet*. Description of computer model and classroom experience. Desert View High School, 4101 East Valencia Rd., Tucson, AZ 85706. March. 7 pp.
- Hopkins, Pamela Lee, 1992. "Simulating *Hamlet* in the Classroom." *System Dynamics Review*, Vol. 8, No. 1, pp. 91-98.
- Mandinach, Ellen B., and Hugh F. Cline, 1989. "Applications of Simulation and Modeling in Precollege Instruction." *Machine-Mediated Learning*, Vol. 3, pp. 189-205.
- Meadows, Donella H., Dennis L. Meadows, and Jørgen Randers, 1992. *Beyond The Limits*, Post Mills, VT: Chelsea Green Publishing Co. 300 pp.
- Meadows, Donella H., Dennis L. Meadows, Jørgen Randers, and William W. Behrens III, 1972. *The Limits to Growth*, New York: Universe Books. 205 pp.
- Pugh, Alexander L., III, 1986. *Professional DYNAMO Plus Reference Manual*. IBM PC computers. 5 Lee St, Cambridge, MA: Pugh-Roberts Associates.
- Richardson, George P., 1991. *Feedback Thought in Social Science and Systems Theory*, Philadelphia, PA: University of Pennsylvania Press. 374 pp.
- Richardson, George P., and Alexander L. Pugh III, 1981. *Introduction to System Dynamics Modeling with DYNAMO*, Cambridge, MA: Productivity Press. 413 pp.
- Roberts, Nancy, 1975. *A Dynamic Feedback Approach to Elementary Social Studies: A Prototype Gaming Unit*. Ph.D. thesis, available from University Microfilms, Ann Arbor, Michigan: Boston University.
- Roberts, Nancy, 1978. "Teaching Dynamic Feedback Systems Thinking: an Elementary View." *Management Science*, Vol. 24, No. 8, pp. 836-43.
- Roberts, Nancy, David Andersen, Ralph Deal, Michael Garet, and William Shaffer, 1983. *Introduction to Computer Simulation: A System Dynamics Modeling Approach*, temporarily out of print, successor publisher not yet known. 562 pp.

Integrating Systems Thinking and Simulation into the Eighth Grade Science Curriculum

Mark Swanson
Frank Draper

Orange Grove Middle School
Tucson, Arizona
July 23, 1991

INTRODUCTION

Since the fall of 1988, an approach to science curriculum delivery called Learner Focused Learning has been evolving at Orange Grove Middle School in Tucson, Arizona. Learner Focused Learning utilizes the power of Systems Thinking, a school of thought that focuses on recognizing the interconnections between parts of a system and synthesizing them into a unified whole (*Systems Thinker*, 1990). It is not merely a way of looking at classroom management, but also a way of viewing content structure and delivery.

In this presentation I will try to explain what Learner Focused Learning looks like to students and teachers and point out the benefits and problems to both groups.

STUDENTS

The best way to describe how Learner Focused Learning affects students is to describe what a typical learning unit looks like.

What a unit looks like to students

The sequence for a typical unit of study includes:

- A. an Introduction
- B. the General Activities
- C. a Main Activity
- D. a Summation

A. Unit Introduction

A new unit of study is introduced to the students as a *gestalt*, an entire system. The introductory discussion includes the following four points:

1. Why we feel the unit needs to be studied at all -- how it is important in the "real world"

THEORY OF THE EARTH

CHAPTER I. OF THE ORIGIN AND GROWTH OF THE EARTH.

THE EARTH, as we see it, is a globe, or sphere, of a very great size. It is composed of a solid mass of matter, which is divided into several parts, or regions, called continents, islands, and seas. The surface of the globe is not perfectly smooth, but is covered with mountains, hills, valleys, and rivers. The air which surrounds the globe is called the atmosphere, and is composed of a mixture of gases. The water which covers the greater part of the globe is called the ocean, and is composed of a mixture of salts and water. The fire which is contained within the globe is called the interior heat, and is the cause of the various changes which take place in the earth.

THE ORIGIN OF THE EARTH is a subject which has long attracted the attention of philosophers. Some have supposed that the earth was created out of nothing, and others that it was formed out of pre-existing matter. The most common opinion is, that the earth was formed out of a mass of gas, which condensed into a solid mass, and then became the earth as we see it. This opinion is supported by the fact, that the earth is still increasing in size, and that the atmosphere is still increasing in density.

THE GROWTH OF THE EARTH is a subject which has also attracted the attention of philosophers. Some have supposed that the earth has always been of the same size, and others that it has increased in size since its creation. The most common opinion is, that the earth has increased in size since its creation, and that it will continue to increase for ever.

- wet labs
- field experiences
- computer simulations
- library/text/reference research experiences
- database construction
- multi-media direct instruction

Lab, classroom, computer and on-campus field experiences are run as concurrent sessions in a multi-task classroom environment. That means that we typically have groups of three or four students working on a task that is different from the other tasks going on in the classroom. The teacher is facilitating up to five different activities at one time. This sounds hectic (and sometimes does get busy!), but the tasks are carefully defined so that student groups call over the teacher only at specified junctures in the activity, or when they dispense information. Tasks are defined carefully to help the students construct their own understanding. Students, after initial frustration about the system in the fall of the year, soon realize that solutions to most problems are up to the group itself, that the teacher will merely ask questions that help them along, not intervene to solve the problem.

Off-campus field experiences are all day affairs, taken in one section groups (about 24-30 students). The flexibility of block, interdisciplinary scheduling allows us to take whole sections of students off campus at a time without having to worry about interrupting other classes or hiring substitute teachers.

C. Main Activity

The main activity is the denouement of the unit. It is here that the students fully make sense of why the content was covered at all. Regardless of the style or medium of the activity, several components are found in every main activity:

1. **mission statements** -- students create goals for the level of their performance within the simulation. Many times mission statements are communicated in terms of graphs demonstrating the anticipated dynamic behavior of the activity.
2. **resources** -- students have constant access to the resources they used and or collected during the general activities. These resources are available at any time.
3. **plan** -- students develop plans (often using scientific thinking processes which control for variables) to do the main activity.

THEORY OF THE EARTH AND ITS HISTORY

The theory of the earth and its history is a branch of geology which deals with the origin and development of the earth and its various parts. It is a science which seeks to explain the processes which have shaped the earth and its features, and to determine the time and sequence of these processes. The theory of the earth and its history is based on the study of the earth's rocks and fossils, and on the principles of geology. It is a science which is constantly developing, as new discoveries are made and new theories are proposed. The theory of the earth and its history is a branch of geology which deals with the origin and development of the earth and its various parts. It is a science which seeks to explain the processes which have shaped the earth and its features, and to determine the time and sequence of these processes. The theory of the earth and its history is based on the study of the earth's rocks and fossils, and on the principles of geology. It is a science which is constantly developing, as new discoveries are made and new theories are proposed.

addition, they learned the content not as disparate parts but as an entire system of relationships and dynamics.

More importantly, students have "experienced," at some level, how the content covered is really being used in the world. Relevancy is not something told them, but something they realize through working with the content. Additionally, each student is overtly interacting with the content in their own way, building understanding. By talking with students on an individual basis, we have a great opportunity to catch misconceptions and confusions.

We have found this approach to be overwhelmingly successful with nearly all students, including mainstreamed "learning disabled" labeled students. The only problems we have encountered have been:

- (1) Some students that are "good at school" have reported that we do not "teach" them, that they wish we would just give them the information so that they could take a test on it.
- (2) Some students that are not "good at school" have reported that they have to "work." Now they cannot hide in a lecture as they used to.

TEACHERS

Planning

Planning for our learner-focused learning units is a time consuming process, but is well worth the effort when we see the results with our students. The process we follow may seem counterintuitive to some, but it structures our thinking towards student-centered learning better than anything else we have tried. The process may be thought of as having five steps.

1. What is the reason for the content?

We ask ourselves: "What do we want citizens to be able to do with this content?" This question helps us establish a real world basis for covering the content. This means that instead of looking at botany as a series of subunits (leaves, stems, reproduction, etc.), we ask, "What do we want citizens to be able to do with the knowledge of plants?" Just the act of asking the question throws our whole focus of teaching into a realm different from having asked the question "What do I want them to know?"

2. How is it to be learned?

Here we ask: "What is the "best" way to learn how to do number one without any constraints in time, money or reality?" This allows us to

Often, we find that we can use activities found in standard published science curriculum materials. We merely need to modify them slightly so that students can see how the activity fits into the entire *gestalt* we have set up. In other words, we try to have students see what sorts of decisions the information learned in the activity helps them make.

Benefits and Problems for Teachers

The benefits for teachers are several:

- The learning environment is more motivating for teachers and students. When students can control much of their own learning and have a good time while doing so, classroom discipline problems drop, and teachers have more time to spend with slower students. We, honestly, have virtually no behavior problems. In an open-ended survey, 70 percent of the students in our classes called the systems, learner-focused learning units the "best part" of the school year.
- This approach is more efficient. For the past two years we have completed in March a curriculum that used to take until June to complete. This is in spite of having added more topics for the students to cover.
- Teachers become creators of environments rather than dispensers of knowledge. We have found that when we are creating, we are happier with our job and work harder to make it better.

The problems for teachers, so far, have included:

- increased time demands during planning (although there is less planning during the actual unit of study.)
- increased demands to communicate what we are doing to administration, parents and other teachers. So far, the response from these groups has been overwhelmingly positive.
- teachers have to be able to tolerate more action in their classrooms as students work with each other in independent ways.

Simulating *Hamlet* in the classroom

Pamela Lee Hopkins

Pamela Hopkins
teaches English at
Desert View High
School in Tucson,
Arizona. Address:
4101 E. Valencia
Rd., Tucson, AZ
85706, U.S.A.

During a STELLA workshop sponsored by the Catalina Foothills School District in Tucson, Arizona, a group of teachers working with Steve Peterson developed a STELLA model that analyzes the motivation of Shakespeare's Hamlet to avenge the death of his father.¹ Plot events lead Hamlet to believe that his uncle, Claudius, has become king by murdering Hamlet's father and marrying his mother, thereby depriving Hamlet of family and throne. The model is designed to expose the effect that plot events have on Hamlet's willingness to kill Claudius. It permits the examination of the impact of each event as it occurs and as Hamlet continues to contemplate the situation.

This note describes the model and its use in high school classes and suggests further directions for simulation to support instruction in literature.

Student population

The *Hamlet* model was used with my students at Desert View High School in Tucson, Arizona. Teaching Shakespearean drama has traditionally been difficult in the Sunnyside District. The complexities of Shakespeare seem to get lost in the demanding daily life of teenagers in this area of Tucson. Tucson is itself a high-crime area with 400,000 residents and 51,542 serious crimes in 1989. While our campus has been declared neutral by the Crips and the Bloods, gang and drug-related activities are ever-present in the community. In addition, many of our students are members of dysfunctional families, generally with only one natural parent present. Quite often the household has been extended to include several related families. Sunnyside District is within 75 miles of the Mexican border, and many of the students are first- and second-generation residents. This often creates language and cultural barriers that are difficult to ease quickly.

Our district has two high schools, each with approximately 1,400 students. Ethnicity is about the same at both schools: the distribution at Desert View is Hispanic, 67%; Anglo, 23%; American Indian, 6%; Afro-American, 3%; and Asian, 1%. A total of 29% of these students participate in the free and reduced-price lunch program. While this cultural diversity offers a certain richness to our campus, there are many associated problems. The lower socioeconomic level of the students further complicates the issue. Many of the high school students are distracted by financial difficulties and are so tired from working part-time that attention to their academic studies lags. It is not surprising that Shakespeare fails to draw their attention.

Presentation procedure

Using a Macintosh SE and the Kodak Datashow, I displayed the model shown in Figure 1 on the A-V screen for my general studies junior literature classes (see the Appendix for equations). I explained the model's components to the students, and they explained the relationship of the components to me by examining the model in light of their knowledge of *Hamlet*. I explained, in about five minutes, that stocks (rectangles) were accumulations; that flows (double lines with an arrow at one end) were pathways for information or material quantities into or out of the stocks; that converters (circles) convert inputs of either the information or material quantities into outputs; and that the wires (thin lines with a circle at one end and arrow at the other) were connectors that reflect the causal linkages between the flows and stocks (they depict the assumptions about "what causes or depends on what" in the model). I defined each item of the model as it related to *Hamlet* without indicating very much of the model creation process. It was my intent to have the students use a systems thinking approach in understanding *Hamlet* so that they could examine human nature and the interaction between events in one's life and one's personality. Therefore, I did not teach them how to use the computer to create a model, although I hope to incorporate model building as a tool for examining literature into the curriculum in the future.

Fig. 1. Diagram of the *Hamlet* model, focusing on the accumulation of evidence in plot events that increase Hamlet's motivation to avenge the death of his father and kill Claudius.

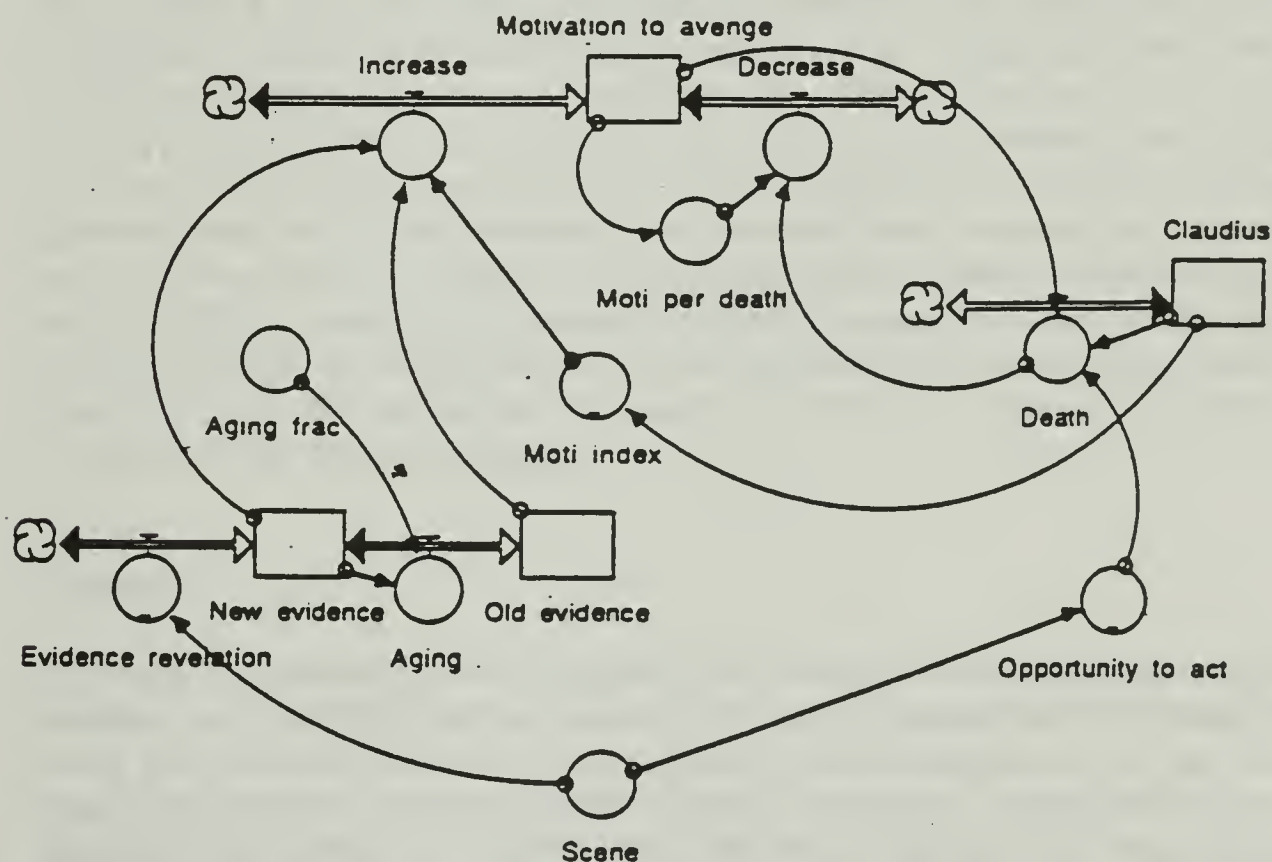
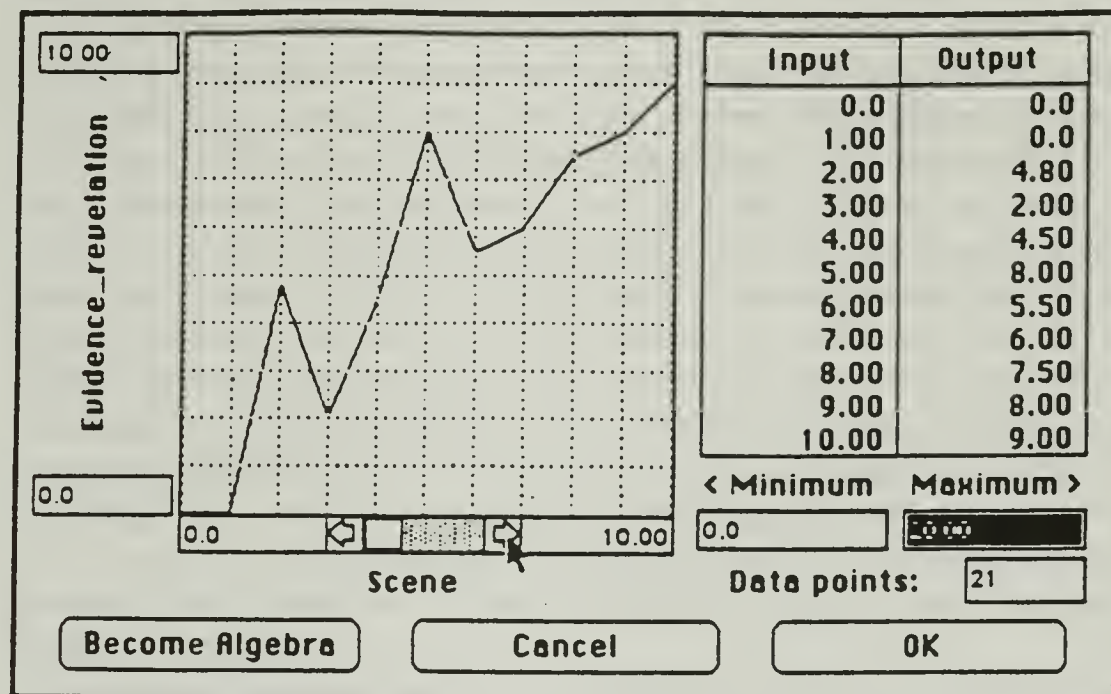


Fig. 2. STELLA window for the "revelation of evidence" flow variable, showing a portion of a typical scene-by-scene-development, suggested by the students, of evidence that would motivate Hamlet to kill Claudius.



When the students indicated a basic understanding of the *Hamlet* motivation model, I opened the window into the "revelation of evidence" flow variable to assign values to the plot events (see Figure 2). As a group, the students examined Act I, scene 1, for events that would influence Hamlet's actions. The students discussed the effect that each event would have on Hamlet's desire to kill Claudius as he became aware of the information, and they assigned accordingly each event a value on a scale of impact from one to ten. We continued analyzing Act I as a group. Then the students broke into small groups of three, with two groups taking each of the remaining acts. As each group presented its "impact study," other students evaluated, and often challenged, values. I entered the data into the STELLA model as the students debated the issues related to each event. Upon completion of the discussion, we ran the model with the numbers derived from the students' discussion. We examined both the model and the graph functions in the STELLA program.

Results

The students were engrossed throughout the process. It was necessary for me to mediate near-hostilities on two occasions within the same class. The amazing thing was that the discussion was completely student-dominated. For the first time in the semester, I was not the focal point of the class. I did not have to filter the information from one student back to the rest of the class. They were talking directly to each other about the plot events and about the human responses being

simulated. They talked to each other about how they would have reacted and how the normal person would react. They discussed how previous events and specific personality characteristics would affect the response to each piece of news, and they strove for precision in the values they assigned for the power of each event. My function became that of listening to their viewpoints and entering their decisions into the computer. It was wonderful! It was as though the use of precise numbers to talk about psychological motives and human responses had given them power, had given them a system to communicate with. It had given them something they could handle, something that turned thin air into solid ground. Instead of my having to force them to keep their attention on the task, they directed and were in control of the learning. Through the systems thinking approach and STELLA, the students guided themselves to a position of understanding. Their value assessments were building understanding with each plot event. I did not have to prompt them at all. They were in complete control of the process. It was what the utopian curriculum lodged in every teacher's dream demands as an outcome.

I simulated the model showing the diagram with stocks and flows animated, and the students murmured foreknowledge when Claudius' life stock emptied into the death converter. I simulated the model showing graphs (Figures 3 and 4 show typical examples), and students spontaneously called out key events when changes occurred. A spike on the graph—"Yeah, there's the climax. Claudius just ran out of the room!" Their creation held their interest completely! They asked to see the model run over and over. Almost immediately, they began changing values. Several students wanted to see the difference in the run if "their" values for the impact of events had been used.

Fig. 3. Typical behavior of the Hamlet model showing the revelation and accumulation of evidence that motivates Hamlet to avenge his father's death.

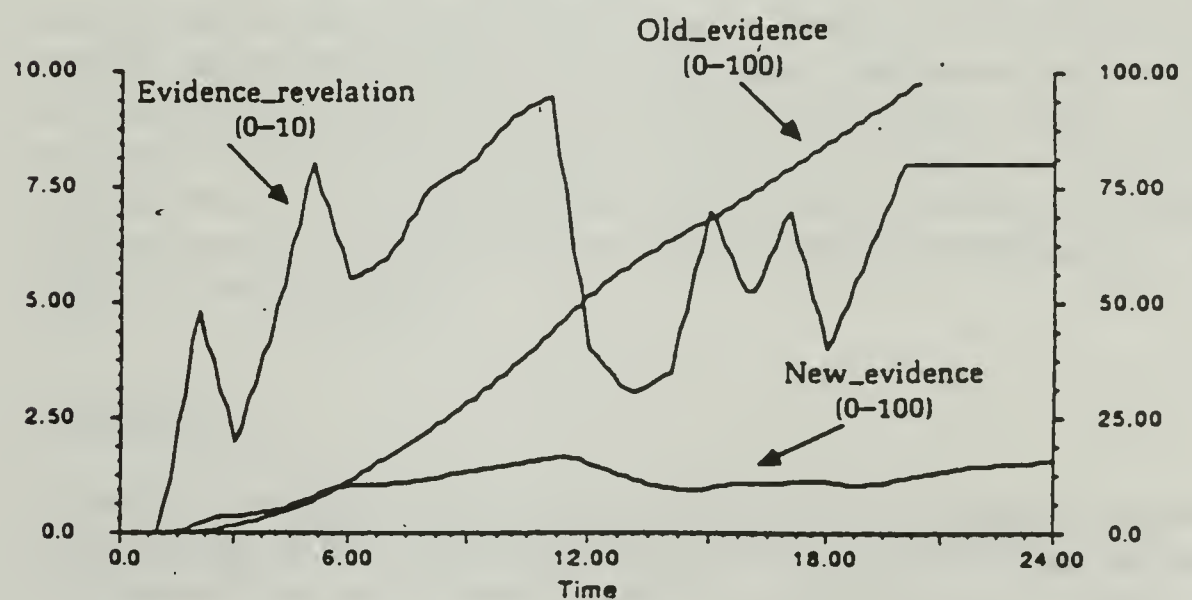
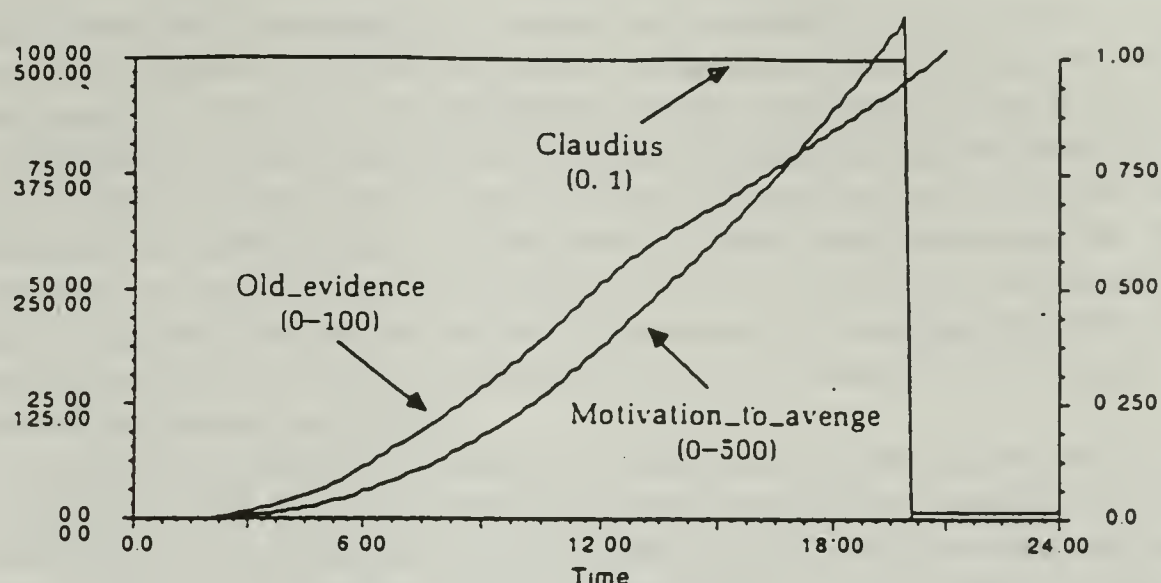


Fig. 4. Other variables from the simulation in Figure 3, showing the accumulation of damaging evidence, Hamlet's growing motivation to avenge his father's death, and Claudius's "life line", which drops to zero at his death.



As the class ended, students moved slowly out the door. Several glanced back at the still running model, waiting to see Claudius die again. Several were still arguing over how much impact just seeing the ghost of a father would have on the ability to make "good" decisions (another aspect in need of modeling). But the crowning moment came when Pete "too cool to participate" Trejo yelled back at me. "Let's try this again Monday with Laertes as our subject."

An examination of the grades for these two classes of juniors indicated the increased level of involvement that the students had in the *Hamlet* unit. The class average went up 10 percent in one class and 10.3 percent in the other. The first class went from having only 3 of 16 students passing to having 10 of 16 passing. One student even achieved a 100 percent mastery for the unit. In the second class, four students who had been failing joined the ranks of the passing. The most dramatic improvement in this class was in obtaining A's and B's. Before studying *Hamlet* with STELLA, only one student in the second class had an A, and there had been no B's. The *Hamlet* unit had three students with A's and five students with B's. Another indicator of student involvement can be found in what followed work with the model. Three students working independently designed activities to extend the unit, two considering *Hamlet* and one using STELLA to study *Amadeus*.

Variations

The model, as simplistic as it currently is, offers a variety of options for classroom activities while studying *Hamlet*. The discussion that occurs during the simulation process is an ideal delivery system for vocabulary study. In addition, one

effective activity, developed by a student, has succeeded in tying *Hamlet* into the rest of the literature curriculum, thereby validating the entire curriculum. Before beginning the drama unit, we studied six literary traditions (the Puritan Age, the Age of Reason, Transcendentalism, the Romantic Age, Realism, and Naturalism). After studying *Hamlet*, the students created a persona from each tradition. Each persona then participated in a discussion of some issue concerning the play. Students had their six characters discuss such topics as Hamlet's sanity and his right to be king. This activity allows the students to integrate what they have learned earlier in the course into the analysis of new material. It goes a long way toward completing the circle.

One student became so involved in the model that he wanted to rewrite the end of the play so that Hamlet survived. Hamlet then would face a tribunal, or a jury, to determine if he were guilty of murder (premeditated?) and if he should be king. This activity would permit careful examination of the evidence presented throughout the play. The students could assume the roles of prosecutor, defense attorney, judge, and jury. Some students could become characters from the play and testify, in character, at the proceedings. (The personas from the previously discussed activity could be included.) Such an activity would develop student awareness of courtroom procedures and the legal system. It would also create an opportunity for students to use critical thinking skills as the detectives and legal counsel worked to "solve the case" and to practice decision-making skills by reaching a verdict. Another advantage would be that students would look deeply into the personality of characters as they prepared to play a character at the trial, increasing their understanding of human nature. I loved the student's idea and plan to try it.

In addition, simulating *Hamlet* permits close consideration of

- A variety of possible responses to the same events
- The effect of rearrangement of the time sequence of events
- The effect of contemplation

With further development, this model could be used

- To manipulate the characteristics of Hamlet to alter his responses to, and the impact of, plot events
- To compare the way other characters would have responded to the same events (Laertes and Fortinbras also had fathers who were killed)
- To manipulate the plot events while maintaining characteristics to examine alterations in response
- To create subplots or additional story lines (maybe a story about another event in Hamlet's life) while maintaining the original story

More models for literature

The success my students experienced with my first attempt at using STELLA to model literature has made me aware of other models that could contribute to units in the English curriculum. The following ideas could be developed:

1. Understanding a short story/play.
 - a. Manipulate personality of a character in published story.
 - b. Maintain personality of a character; manipulate plot.
 - c. Introduce a new character; maintain all other characters; watch plot change.
 - d. Alter setting; focus on plot and character effects.
 - e. Substitute a character from one story/play for one in another story/play (Romeo as Hamlet; Montressor as Hamlet; Hamlet as Romeo).
 - f. Incorporate a character from one story/play into another story/play (Romeo into Hamlet).
2. Writing a short story/play.
 Use the model to help writers focus on the development of plot, the impact of setting, and the consistency of characterization. Many of the possibilities listed in (1) could be used.
3. Literary analysis. Use the model to focus on thematic concepts and points of character.
 - a. *Julius Caesar*—ambition, self-sacrifice for the state.
 - b. *Romeo and Juliet*—communication, coincidence, fate, youth, the generation gap, tradition.
 - c. *Macbeth*—ambition, spousal relationships, appearance versus reality.
 - d. "The Most Dangerous Game"—empathy.
 - e. "The Cask of Amontillado"—revenge.
 - f. "To Build a Fire"—decision making.
 - g. *Animal Farm*—progression of human faults.

Appendix: Equations for Hamlet's motivation-to-avenge model

```

Claudius = Claudius + dt * ( -Death )
INIT(Claudius) = 1
Death = IF (Motivatio_to_avenge ≥ 95) and (Opportunity_to_act ≥ .95)
  then Claudius/dt else 0
Motivatio_to_avenge = Motivatio_to_avenge + dt * ( Increase - Decrease )
INIT(Motivatio_to_avenge) = 0
Increase = (New_evidence*Moti_index)+(Old_evidence*Moti_index*.5)
Decrease = Death*Moti_per_death
New_evidence = New_evidence + dt * ( Evidence_revelation - Aging )
INIT(New_evidence) = 0

```

```

Evidence_revelation = graph(Scene)
  (0.0,0.0),(1.00,0.0),(2.00,4.80),(3.00,2.00),(4.00,4.50),(5.00,8.00),
  (6.00,5.50),(7.00,6.00),(8.00,7.50),(9.00,8.00),(10.00,9.00),
  (11.00,9.50),(12.00,4.00),(13.00,3.00),(14.00,3.50),(15.00,7.00),
  (16.00,5.00),(17.00,7.00),(18.00,4.00),(19.00,6.00),(20.00,8.00)
Aging = New_evidence*Aging_frac
Old_evidence = Old_evidence + dt * ( Aging )
  INIT(Old_evidence) = 0
Aging_frac = .5
Moti_per_death = Motivatio_to_avenge
Scene = time
Moti_index = graph(Claudius)
  ( 0.0, 0.0),(0.0500, 0.0),(0.100,0.950),(0.150,0.950),(0.200,0.950),
  (0.250,0.950),(0.300,0.950),(0.350,0.950),(0.400,0.950),(0.450,0.950),
  (0.500,0.950),(0.550,0.950),(0.600,0.950),(0.650,0.950),(0.700,0.950),
  (0.750,0.950),(0.800,0.950),(0.850,0.950),(0.900,0.950),(0.950,0.950),
  (1.00,0.950)
Opportunity_to_act = graph(Scene)
  ( 0.0,0.720),(1.00,0.670),(2.00,0.650),(3.00,0.620),(4.00,0.525),
  (5.00,0.350),(6.00,0.260),(7.00,0.240),(8.00,0.200),(9.00,0.205),
  (10.00,0.190),(11.00,0.190),(12.00,0.195),(13.00,0.195),(14.00,0.195),
  (15.00,0.195),(16.00,0.200),(17.00,0.595),(18.00,0.595),(19.00,0.610),
  (20.00,1.00)

```

Note

1. STELLA—High Performance Systems. Inc., 45 Lyme Rd., Hanover, NH 03755. U.S.A.

Learning through System Dynamics as Preparation for the 21st Century

by
Jay W. Forrester

Germeshausen Professor Emeritus
and Senior Lecturer
Sloan School of Management
Massachusetts Institute of Technology

Keynote Address
for
Systems Thinking and Dynamic Modeling Conference
for K-12 Education

June 27-29, 1994
at
Concord Academy
Concord, MA, USA

Copyright © 1994
by Jay W. Forrester
Permission granted to reproduce
for noncommercial and educational purposes.

Contents

| | |
|---|-----------|
| DEVELOPING PERSONAL SKILLS | 5 |
| Basis for Clear Thought and Communication | 5 |
| Building Courage | 7 |
| Personal Philosophy | 8 |
| Seeing Interrelatedness | 9 |
| "Renaissance Man," Unifying Knowledge, Mobility | 9 |
| OUTLOOK AND PERSONALITY | 10 |
| Confidence in Creating the Future | 11 |
| Authoritarian vs. Innovative Personality | 11 |
| Mental Models and Computer Models | 12 |
| UNDERSTANDING THE NATURE OF SYSTEMS | 14 |
| Cause and Effect Not Closely Related in Time or Space | 14 |
| Low-Leverage Policies | 15 |
| High Leverage Policies, Often Wrongly Applied | 15 |
| We Cause Our Own Problems | 16 |
| Drift to Low Performance, Collapse of Goals | 17 |
| Long-Term vs Short-Term Goals | 18 |
| ACHIEVING THE BENEFITS OF A SYSTEMS EDUCATION | 19 |
| Experience and Participation | 19 |
| The Deeper Lessons | 19 |
| Systems Thinking vs System Dynamics | 19 |
| Revision of Road Maps | 20 |
| On Teaching Systems | 20 |

Learning through System Dynamics as Preparation for the 21st Century

by
Jay W. Forrester

This conference emphasizes systems thinking and system dynamics modeling. But what should such activities accomplish? We do not expect most students to spend their lives in front of a computer building system dynamics models. What should be the outcome of a systems education beyond the subjects in this week's program?

I believe we should give students a more effective way of interpreting the world around them. They should gain a greater and well-founded confidence for managing their lives and the situations they encounter.

The objectives of a system dynamics education might be grouped under three headings:

1. Developing personal skills,
2. Shaping an outlook and personality to fit the 21st century, and
3. Understanding the nature of systems in which we work and live.

DEVELOPING PERSONAL SKILLS

A system dynamics education should sharpen clarity of thought and provide a basis for improved communication. It should build courage for holding unconventional opinions. It should instill a personal philosophy that is consistent with the complex world in which we live.

Basis for Clear Thought and Communication

The ordinary spoken and written language allows a person to hide behind ambiguous, incomplete, and even illogical statements. Language, within itself, does not impose a discipline for clarity and consistency. By contrast, computer modeling requires clear, rigorous statements.

Copyright © 1994
by Jay W. Forrester
Permission granted to reproduce
for noncommercial and educational purposes.

In ordinary discussion, a general statement like, "How people respond depends on the situation," might be accepted. But, if this were to become an input for a model, one would be forced to specify which people, what response, dependence on what specific aspect of the situation, and what precise action would to be taken under various conditions.

Students must struggle to achieve the precision of expression required to go from language to explicit statements in a simulation model. Even a process as simple as filling a bathtub with water, or describing the cooling of a cup of coffee, can be surprisingly demanding. Such clarity is not achieved after only a few exercises. Learning precision in thinking requires years of reinforcement.

Translating from descriptive language to model language is only half of the story. One can then make the reverse translation. From a simulation model, reverse translation to descriptive language yields clear statements that embody the precision that came from building and using the model.

I experienced the power of reverse translation from a system dynamics model after publication of my *Urban Dynamics* book dealing with the growth and stagnation of cities (Forrester, 1969). The book achieved such visibility that I would be invited to conferences on urban problems held anywhere in the world. At such meetings, I had a unique power and influence derived from being able to talk for 20 minutes without contradicting myself. Not contradicting oneself might seem an ordinary competence. But others could not hope for comparable clarity because of incompleteness and inconsistency in their thinking about complex situations. Furthermore, they could not draw the correct dynamic consequences for the future implied by the assumptions they were making. To know the behavior that follows from assumptions about parts of a system can be achieved only through modeling and computer simulation.

In my situation at the conferences on cities, I knew the assumptions that went into the *Urban Dynamics* model. I knew the behavior that resulted from those assumptions. Also, I knew how the behavior would change if one adopted different political policies for guiding the evolution of a city. Within the framework of the model, I could be entirely consistent in everything that I said. Of course, one can be internally consistent and still be wrong or irrelevant. So, beyond consistency, it was necessary that the model also overlay and connect with the issues of interest to others.

Students should come out of a systems education convinced that a much better understanding is possible in the present puzzling behavior of personal, social, economic, and business situations. They should realize that any debate about policies for the future can be clarified and made more meaningful if someone

will make the underlying assumptions explicit and show which assumptions lead to behavior that best fits the knowledge we have of the real world.

Students in kindergarten through 12th grade should have the repeated experience of using modeling to resolve debates, misunderstandings, and differences of opinion. One discovers that the most intense disagreements usually arise, not because of differences about underlying assumptions, but from different and incorrect intuitive solutions for the behavior implied by the assumptions. In building a system dynamics model, one starts from the structure and the decision-making rules in a system. Usually there is little debate about structure and the major considerations in decisions. When a model has been constructed from the accepted structure and policies, the behavior will often be unexpected. As the reasons for that behavior become understood, I have often seen extreme differences of opinion converge into agreement.

Students should see modeling and an understanding of systems as a way to reduce social and political conflict.

Building Courage

A strong background in modeling should show students that conventionally accepted opinions about social and economic policies are often actually the causes of our most serious problems. If they realize that popular opinions are not necessarily correct, they should develop courage to think more deeply, look beyond the immediate situation, and stand against majority opinion that is ill founded and short sighted.

Working with models should not only enhance skill in making precise statements, but also bolster the courage to do so. Very often people take refuge in statements that are so general, so incomplete, and so superficial that they cannot be proved wrong. On the other hand, such vague statements can not be effective.

Making precise statements opens one to being wrong. By a precise statement I mean one that is unambiguous. A precise statement has a unique meaning; it is clear. However, a precise statement is not necessarily accurate or correct. Precise statements are necessary for clear communication. If such statements are wrong, that will be more quickly discovered if communication is clear. In model building, students will many times have the experience of making assertions that model simulations demonstrate to be incorrect. Students should develop the courage to be precise, even if wrong, in the process of learning and improving understanding.

Personal Philosophy

Experience in computer simulation should change the way students respond to the world around them.

From simulation models, students should appreciate the complexity of social and economic systems, whether those systems be at the level of families, communities, corporations, nations, or international relationships. They should have seen many times the counterintuitive nature of such systems. They should understand that "obvious" solutions to problems are not always correct, and that apparently correct actions are often the causes of the very problems that are being addressed.

The *Urban Dynamics* book illustrates how well-meaning actions can worsen conditions that the actions are intended to alleviate. The book showed how most popular governmental policies all lay somewhere between neutral and highly detrimental, either from the viewpoint of the city as an institution, or from the viewpoint of unemployed low-income residents. The most powerful influence on a city was shown to be the policy governing building of low-income housing. The United States has followed a policy that makes urban poverty worse. As a city ages, it becomes imbalanced. As industrial structures grow older, they are used in ways that employ fewer people. However, as housing ages, it drifts to lower rents and higher population densities. Building low-income housing accelerates the rate of decay. The "obvious" policy of building low-cost housing occupies land that could have been used for job-creating business structures while at the same time the housing attracts still more people who need jobs. The apparently humanitarian policy of building more housing actually creates poverty by pulling people into areas of declining economic opportunity.

We can hope that students will develop caution about jumping to premature conclusions and will search for a wider range of alternatives.

Even if individual students do not construct models in later life, they should expect that system dynamics models will be constructed by those who are proposing changes in economic and social policies. Moreover, in the 21st century, citizens should expect that such models will be made available for public inspection. From their K through 12th grade experiences they will know that they can read, understand, and evaluate such models. More and more, computer models will be used as the basis for determining social and economic policies. In order to participate, the public will need to know the nature of such models, to evaluate the assumptions in models, and to feel comfortable in pushing the proponents of policy models to reveal their assumptions and to justify their conclusions.

Seeing Interrelatedness

Interrelationships in systems are far more interesting and important than separate details. The interrelationships reveal how the feedback loops are organized that produce behavior. Students with a strong background in systems modeling should be sensitized to the importance of how the world is organized. They should want to search for interconnecting structure that gives meaning to the parts.

One sees the significance of modeling in a discussion I had with a student who had graduated from MIT several years before. I asked him what his system dynamics study had done for him. His answer: "It gives me an entirely different way of reading the newspapers." He meant that he sees the relationships between different things that are happening today, he understands the relationships between today's news and what happened last week and last year, and he reads between the lines to know what must have been part of the story but was not reported.

"Renaissance Man," Unifying Knowledge, Mobility

The 21st century will exhibit rapid changes in societies. We already see turmoil in the former Soviet Union and in Africa. In the past century, change came from new technologies. In the next century I believe change will be driven mostly by population growth, crowding, environmental degradation, pollution, and shortages of food, water, and resources. In other words, societies will be continually reshaped and, as a consequence, the roles of individuals will continually change. Today's students should be prepared for unexpected change.

Education must reverse the trends of the last century toward more and more specialization. A specialization interest can start early in life and lead to a professional training in college that will often become obsolete within an individual's working career. Education should provide a foundation that gives a student mobility to shift with changing demands and opportunities.

System dynamics provides a foundation underlying all subjects. When that foundation is mastered, an individual will have mobility to move from field to field. An MIT undergraduate in electrical engineering demonstrated such mobility. He studied system dynamics during his junior and senior years. When he continued for a master of science degree in electrical engineering, he did his thesis on the way the body handles insulin and glucose in various aspects of diabetes. That may not sound like electrical engineering, but about 10% of such students move on to careers in medicine. He immediately developed a working-colleague relationship with doctors in Boston's research clinic for diabetes because for the

first time they were able to put together their fragments of medical knowledge into a meaningful system (Foster, 1970). But he did not intend to go into medicine. He next worked with me in extending the *Urban Dynamics* model. For a year, he led discussions with a group from Boston's black community to incorporate many aspects of education into the model. Later he went to work with a corporation. He could move from one setting to another because his fundamental understanding of systems allowed him to provide a dynamic organizing framework to any activity.

A person with an understanding of systems sees the common elements in diverse settings rather than focusing on differences. For example, communities may have identical basic structures but behave quite differently because of different policies that are followed at crucial places. Systems with the same structure show the same range of behaviors. For example, a simple two-level model for a swinging pendulum can be relabeled and it becomes oscillating employment and inventories at the core of economic business cycles.

I had an opportunity to illustrate transferability of structure in a discussion with several medical doctors and pharmacologists. They had described an experimental treatment that a research doctor was trying. Nothing had been said about the results when I suggested, "Let me try something here. If I were to judge that treatment by the behavior we saw in the *Urban Dynamics* model of growth and decline in cities, I would predict that treatment would cause atrophy of the pancreas." And they responded, "You are right, that is exactly what happens." We expect that students should develop ability to transfer understanding of dynamic structures among very different fields.

Transferability of structure and behavior should create a bridge between science and the humanities. Feedback-loop structures are common to both. An understanding of systems creates a common language. Science, economics, and human behavior rest on the same kinds of dynamic structures.

I see a reversal of the trend toward specialization. As the underlying unity between fields becomes teachable, we can move back toward that concept of the "Renaissance Man," who has broad intellectual interests and is accomplished in areas of both the arts and the sciences.

OUTLOOK AND PERSONALITY

A systems education should give students confidence that they can shape their own futures. A systems education should help mold a personality that looks for causes and solutions. Working with systems should reveal the strengths and

weaknesses of mental models and show how mental models and computer models can reinforce one another.

Confidence in Creating the Future

Many of the stresses in modern life arise because people feel buffeted by forces they neither understand nor know how to control. Such sense of helplessness can be traced to not understanding the systems of which we are a part. Events that seem capricious when viewed locally are often understandable when seen from a broader systems perspective.

I hope that a system dynamics thread in K through 12 education would leave individuals willing and able to appreciate the nature of complexity. They should want to look beyond their immediate setting in search of the fundamental causes of problems. They should develop optimism about understanding those problems of society that earlier generations have found so baffling. Inflation, wars, unfavorable balance of trade, and destruction of the environment have persisted for hundreds of years without public understanding of the causes. Such problems are too serious to be left to the self-appointed experts; the public must acquire the insights that permit participation in debates of such importance.

Such better understanding comes in small steps. I am reminded of the story told by a television producer who was taking video pictures in a group of parents, teachers, and students at a school where the systems approach is making excellent progress. The producer turned to a junior high school boy and asked, "What have these systems studies meant to you?" His immediate answer: "I am much better able to deal with my mother."

Such ability to deal better with one's environment starts with even very simple systems. One of our MIT doctoral students in system dynamics went to work for the Department of Energy. Two years later he told me he was amazed by the amount of influence he could have on governmental thinking with a two-level simulation model. Even such a simple system is often beyond what people in important policy positions are taking into account.

Authoritarian vs. Innovative Personality

A systems education should mold the personality of students by enhancing innovative tendencies in children and counteracting the forces in society that convert an innovative personality into an authoritarian one. I am here using authoritarian and innovative personalities in the sense described by Everett Hagen

in his book; *On the Theory of Social Change* (Hagen, 1962). Hagen contrasts two opposite extremes of personality.

The authoritarian personality fits into a rigid hierarchy. Life is capricious. One does as ordered by those of higher status. There are no reasons for such orders. Capricious orders fit the old army saying borrowed from Tennyson, "Yours not to reason why, yours but to do and die." The reward for yielding to higher authority comes from the individual having authority over someone of lower rank. The pure authoritarian personality expects no reasons for why things happen and has no will to search for reasons.

By contrast, the innovative personality believes there are reasons for why things happen. Even if the reasons are unknown, there is still the assumption that reasons exist. Also, it is worth looking for the reasons because, if one understands, then one can probably change and improve what is happening. The innovative personality looks for causes and works toward beneficial advances.

I believe that babies are born as innovative personalities. They want to explore, to understand, and to see how things work and how to master their environments. But our social processes work to stamp out exploration and questioning. The child is continually confronted with, "Do as you are told," or "Stop asking questions and just mind me," or "Study this because it is good for you." Repeated restraint of innovative inclinations gradually forces personalities into the authoritarian mold.

A system dynamics modeling curriculum, by letting students formulate the structure and policies causing behavior under study, will help preserve and rebuild the innovative outlook. Simulation emphasizes reasons for consequences. To be innovative, one must be willing to make mistakes while searching for reasons and improvement. Computer simulation modeling is a repeating process of trial and error. One learns that progress is made through exploration and by learning from mistakes. An authoritarian personality fears mistakes and does not try the unknown. An innovative personality knows that mistakes are stepping stones to better understanding.

Mental Models and Computer Models

Students should learn that all decisions are made on the basis of models. Most models are in our heads. Mental models are not true and accurate images of our surroundings, but are only sets of assumptions and observations gained from experience.

Mental models control nearly all social and economic activities. Mental models have great strengths, but also serious weaknesses. From a systems education, students should learn how mental models can be useful and when they are unreliable. Furthermore, they should appreciate how computer simulation models can compensate for weaknesses in mental models.

Mental models contain a vast wealth of information that is available nowhere else. Mental models contain information about the structure and policies in systems. By structure I mean the elements in a system and the connections between the elements—who has what information, who is connected to whom, and, what decisions are made and where. By policies I mean the rules that govern decision making—what factors influence decisions, what is a particular decision point trying to accomplish, and what goals are sought. At this detailed level of structure and policies, mental models are rich and reasonably reliable sources of information.

However, mental models have serious shortcomings. Partly, the weaknesses in mental models arise from incompleteness, and internal contradictions. But more serious is our mental inability to draw correct dynamic conclusions from the structural and policy information in our mental models.

System dynamics computer simulation goes a long way toward compensating for deficiencies in mental models. In model building, one must remedy incompleteness and internal contradictions before the system dynamics software will even allow simulation. After a logically complete model has been created, one can be certain that the computer is correctly simulating the system based on the assumptions that were incorporated in the model. It is in simulation, or determining consequences of the structural and policy assumptions, that mental models are unreliable, but computer models are completely dependable.

Students should also realize that there are no possible proofs of the validity of any models, whether they are mental or computer models. Models are to be judged by their comparative usefulness. Assumptions about structure and policies should be compared with any available information. Computer simulation results should be compared with behavior in the real system being represented. Discrepancies lead to improving both mental and computer models.

A two-way street runs between mental models and computer models. Mental models contribute much of the input for computer models. Creating a computer model requires that the mental models be clarified, unified, and extended. From the computer simulations come new insights about behavior that give new meaning to mental models. Mental models will continue to be the basis

for most decisions, but those mental models can be made more relevant and more useful by interacting with computer models.

UNDERSTANDING THE NATURE OF SYSTEMS

We live in a network of complex systems. Yet few people realize the extent to which those systems control human actions. In fact, few people realize the extent to which complex systems actively mislead people into making counterproductive decisions. Students, after a 12-year encounter with systems, should be on guard against the deceptive nature of systems.

Cause and Effect Not Closely Related in Time or Space

Most understandable experiences teach us that cause and effect are closely related in time and space. However, the idea that the cause of a symptom must lie nearby and must have occurred shortly before the symptom is true only in simple systems. In the more realistic complex systems, causes may be far removed in both timing and location from their observed effects.

From earliest childhood we learn that cause and effect are closely associated. If one touches a hot stove, the hand is burned here and now. When one stumbles over a threshold, the cause is immediately seen as not picking the foot high enough, and the resulting fall is immediate. All simple feedback processes that we fully understand reinforce the same lesson of close association of cause and effect. However, those lessons are aggressively misleading in more complex systems.

In systems composed of many interacting feedback loops and long time delays, causes of an observed symptom may come from an entirely different part of the system and lie far back in time.

To make matters even more misleading, such systems present the kind of evidence that one has been conditioned to expect. There will be apparent causes that meet the test of being closely associated in time and in location. However, those apparent causes are usually coincident symptoms arising from the distant cause. People are thereby drawn to actions that are not relevant to the problem at hand.

Comments such as I have just made about cause and effect carry little conviction from being stated in a lecture. Only after a student has repeatedly worked with models that demonstrate such behavior, and has had time to observe the same kinds of behavior in real life, will the idea be internalized and become part of normal thinking.

Low-Leverage Policies

Complex systems differ from simple systems in another way. In simple systems, the policies to yield better results are obvious and they work. To avoid burning your fingers on a hot stove, you keep away from the stove. But in complex systems, the apparently influential policies often have very little effect.

When I talk to a group of business executives I ask how many have ever had the experience of facing a serious problem, devising policies to correct the situation, and five years later find there has been no improvement. Most will hold up their hands. Perhaps you have experienced the same in education. The quality of education has been severely criticized, many educators have tried remedies, and often there is little change.

In complex systems, there are many interconnecting feedback loops. A new policy, which is intended to solve a problem, causes reactions in other parts of the system that counteract the new policy. In education that reaction may come from administrators, from school boards, from parents who do not want new experimental ideas tried on their children, or from budget pressures.

I believe that a very high percentage, say 98%, of the policies in a system have very little leverage to create change. They do not matter. However, most of the heated debates in communities, companies, and governments are about policies that are not influential. Such debates are a waste of time and energy. Debates about low-leverage policies divert attention from the few policies that could lead to improvement.

Students must have experience working with models of complex systems to appreciate how often proposed policies fail to produce results.

High Leverage Policies, Often Wrongly Applied

Fortunately, a few high-leverage policies exist that can alter the behavior of a system. However, high-leverage policies lay another trap for the unwary. One occasionally finds a person who is working with a high-leverage policy. However, I estimate that more than 90% of the time that person is pushing the high-leverage policy in the opposite direction relative to what that person wants to accomplish. In complicated systems, intuition provides no reliable guide even to the direction that a high-leverage policy should be changed.

I have several times had the experience of going into a company with a serious difficulty where intended policies were causing the problem. We are talking here of a highly visible problem. It might be low profitability, or falling market share, or severe instability with the company working overtime one year and having half the people laid off two years later. One carries on extensive interviews to determine the policies (decision-making rules) that people are using in different positions in the company. People justify their policies as intended to solve the major problem. One then puts the expressed policies into a system dynamics simulation model and finds that the model generates the same difficulty that the company is experiencing. In other words, the policies that people know they are following are the cause of their trouble. Local interpretation of symptoms leads to local actions that combine to produce detrimental results. This is a treacherous situation. If people believe their actions will reduce the problem, but do not know those actions are making it worse, then as matters become worse there is growing incentive to take the presumed corrections that are actually causing further decline.

One sees this spiral of system deterioration at all levels in society. Individuals in a family in serious psychiatric difficulty know they are in trouble, each wants to do something to help, yet everything that everyone does makes matters worse. In the *Urban Dynamics* model, we saw that governmental policies about low-cost housing do not improve cities but cause more decay. In the same way, we might suspect that our national foreign trade policies lead to importing goods made by low-skilled labor while our own low-skilled population lose the jobs that could provide an employment and training ladder to higher skills.

I do not know of any way to determine which are high-leverage policies and which direction to apply them except to do a systems dynamics simulation of the situation. Students should have many experiences working with models that reveal the multitude of policies having little effect, that allow them to search for high-leverage policies, and that show them the danger of intuitively judging even the direction of effect of high-leverage policies. Students should come out of a systems education with an appreciation for how mental models alone can lead one astray in multiple-loop systems. They should demand that important issues be modeled, and that the models be made available to the public. They should have confidence that they can read and evaluate such models. Models then become a powerful and explicit means of communication.

We Cause Our Own Problems

The often quoted line from the comic strips, "We have met the enemy, and he is us," has more than a grain of truth. Usually, problems exhibited by a social system are caused by the people in that system. However, people naturally tend to

blame others. When Detroit was losing market share to Japanese automobiles, executives of American companies blamed Japan for dumping at low prices, when the real cause was Detroit's own declining quality. Parents blame schools for low competence of students, when perhaps the deficiency arises more from preschool home life and failure in parental guidance. A company is more inclined to blame falling sales on unfair competition or fickle consumers than on its own poor products and service.

In preparation for the 21st century, a systems education should condition students to look for the source of their troubles first in their own actions before blaming others.

Drift to Low Performance, Collapse of Goals

One component of any feedback loop is the goal toward which the feedback process is striving. In simple models, goals are usually given as constants, for example, the goal of a pendulum is to seek the vertical as it swings from one side to the other. The goal of an inventory manager may be to maintain a given level of inventory. The goal that determines the amount of sleep we get is to maintain a certain degree of restfulness. But in a more complete representation of systems, the goals themselves are properly shown as variables. We may be striving toward a certain goal, but, failing to reach the goal, we may readjust our goal to something that seems more achievable.

There is a strong tendency for goals of all kinds—personal, community, corporate, or national—to drift downward. Pressures tend to cause performance to fall short of goals. But failing to meet goals is uncomfortable. The response is often to let the goals adjust downward toward the actual performance. As goals fall, the incentives for high achievement decline. Performance continues to fall short of the new lower goals and the downward spiral continues.

Falling goals will in time lead to crisis, but by then recovery may be impossible. One sees erosion of goals in attitudes toward the national deficit. Thirty years ago, the present size of the national deficit would have been unthinkable. But as the deficit rose, people came to accept each new rise and adjusted to the higher deficit. Eventually such goal erosion can lead to disaster. Successful people, successful corporations, and successful countries have leadership or deeply held beliefs that stop such goal erosion.

Students should be exposed to the dynamics of goal collapse in models and have an opportunity to relate the process to their own lives. Goal collapse, that is, becoming accustomed to and accepting falling standards, may be the greatest threat to the future of individuals and countries.

Long-Term vs Short-Term Goals

A fundamental conflict exists between short-term and long-term goals. Students should observe this conflict between the present and the future in system dynamics models and then relate the lessons to their own lives. Actions that yield immediate rewards almost always exact punishment in the long run, and vice versa. Quick gratification is the enemy of future well-being. It is hard to find exceptions where actions with an immediate reward do not extract a price in the more distant future.

A person who steals may benefit immediately, but usually suffers later. A person who works all night to finish an important task pays by being inefficient for the next several days. Taking mind-altering drugs may give an immediate sense of well being at the expense of future ill health or poverty. Borrowing on credit cards allows an immediate increase in standard of living but the consequence in the longer term is a lower standard of living while paying back the loan and interest. Under pressure from voters, the U.S. Congress is borrowing money to provide ever-increasing goodies to constituents, with the probable future consequence that government becomes insolvent and may not be able to provide basic public services. Over a much longer time horizon, improved public health and modern agriculture raised the standard of living and reduced death rates, resulting now in the threat of an unsustainable population explosion.

Conversely, accepting a short-term disadvantage can often yield rewards in the longer-term. For example, saving now, rather than spending all one's income, can increase the future standard of living. A company that foregoes higher dividends and increased executive salaries can invest in research on new products and increase future income.

The conflict between short-term and long-term goals bears directly on what should be considered ethical and humanitarian. Humanitarian impulses are usually based on short-term considerations but often lead to worsening the situation in the more distant future. Food aid to starving populations seems humanitarian in the short run, but may well encourage population growth and greater starvation of even more people in the future.

Students should study the fundamental conflicts between short-term and long-term goals in the context of system dynamics models and have the opportunity to relate the lessons to their families, communities, and nation.

ACHIEVING THE BENEFITS OF A SYSTEMS EDUCATION

A systems thinking and systems modeling curriculum will not automatically yield the lifetime insights and personal guidance that I have been discussing. A student might easily go through the motions of working with models without gaining the understanding that is potentially available.

Experience and Participation

Students will not internalize their understanding of systems merely from being told. Nor will discussion and debate be effective. Coming to an understanding of systems must be a participative activity. Learning about systems is not a spectator sport, such learning comes from active involvement. One does not learn to ride a bicycle or play basketball from lectures alone; one must practice. A person learns from experience. Computer modeling allows an accelerated vicarious experience.

The Deeper Lessons

A student can work with computer simulation models without realizing the deeper lessons that should be absorbed. Most learning for the 21st century that I have discussed can be missed by students unless the right guidance is provided. Students must create their own models and learn from trial and error. They must be led toward models that can teach the lessons that I have been discussing. Even with models that contain the lessons, students can miss the most important implications, so they should be encouraged to see the deeper consequences of what they are doing. They should relate what they are learning to systems they already know in families, community, and school.

Systems Thinking vs System Dynamics

This conference is advertised as "Systems Thinking and Dynamic Modeling." Consider those two activities in the context of learning for the 21st century. I understand and define the two terms, systems thinking, and dynamic modeling, to mean quite different activities.

Systems thinking appears to be thinking about systems, talking about the characteristics of systems, acknowledging that systems are important, discussing some of the insights from system archetypes, and relating the experiences people have with systems. Systems thinking is lecturing about systems as I am doing tonight. Systems thinking can be a door opener and a source of incentive to go deeper into the study of systems. But I believe that systems thinking has almost no

Introduction to the Study of the History of the English Language

The purpose of this book is to provide a comprehensive overview of the history of the English language, from its origins in Old English to its development in the modern world. The book is divided into several chapters, each focusing on a different period or aspect of the language's history.

Chapter 1: The Origins of the English Language

The English language is a member of the Indo-European family of languages, which includes many other major languages of the world. It is believed that the English language originated in the British Isles, where it was first spoken by the Anglo-Saxons. The language then spread to other parts of the world, including North America, Australia, and South Africa.

Chapter 2: The Development of the English Language

The English language has undergone a significant process of development over the centuries. It has absorbed many words from other languages, particularly from French and Latin. It has also developed its own unique grammar and syntax. The language has continued to evolve, and it is expected that it will continue to do so in the future.

Chapter 3: The Influence of the English Language

The English language has had a profound influence on the world. It is the most widely spoken language in the world, and it is the language of international communication. It has also been the language of many great works of literature and art.

The English language is a dynamic and ever-changing language. It is a language that has shaped the world, and it will continue to shape the world in the future. It is a language that is full of life and energy, and it is a language that is worth studying and appreciating.

chance of instilling the lessons that I have described. Systems thinking will change very few of the mental models that students will use in their future decision making. Systems thinking is not more than five percent of a systems education.

On the other hand, system dynamics modeling is learning by doing. It is learning through being surprised by the mistakes one makes. System dynamics modeling is a participative activity in which one learns by trial and error and practice. I believe that immersion in such active learning can change mental models.

Revision of Road Maps

Many of you are already familiar with the Road Maps series being written by undergraduate students at MIT with my guidance. Road Maps are documents intended as a self-study guide to learning about systems. First drafts of four chapters have been available through the Creative Learning Exchange.¹

However, in thinking about lessons that students should learn, it became clear that intended insights about systems could be missed. Work with systems was there, but implications had not been stressed. We are now revising the early drafts of Road Maps to be more explicit about fundamental principals of systems and to call attention to the general characteristics of systems that should be observed. The series is also being extended to more comprehensive chapters.

On Teaching Systems

I believe that confining student learning to systems thinking and to discussion about systems will convey very little understanding of the nature and behavior of the systems within which we live.

To appreciate the nature of systems, students must have extensive personal experience in working with systems. This means creating system dynamics models on a computer, simulating their behavior, exploring how the models respond to changes in structure and policies, and comparing model behavior to the real systems being represented. Such active modeling should extend at least throughout the several years of middle school and high school. As early as possible, schools should move away from canned models that have been previously prepared for student use. Instead, students should create models, examine their short comings, and learn from discovering improvements.

¹ Creative Learning Exchange, Lees Stuntz, Executive director, 1 Keefe Road, Acton, MA, 01720, tel: 508-287-0070, fax: 508-287-0080.

Students should gain experience in modeling systems in which they have a personal interest. Such systems can be drawn from family and community situations. Items from the newspapers should be converted to formal models to reveal student understanding of current events, to detect omissions and contradictions in the news items, and to provide practice in moving in both directions between mental and computer models. History and literature likewise provide material that can be made more explicit and understandable through modeling.

Throughout student work with models, more should be learned than just the details of the models themselves. Beneath such models are the underlying principles of systems (Forrester, 1968). Beyond such models are the kinds of learning discussed in this talk. Students probably will not see such general and transferable insights merely from exposure to models. The larger and more enduring lessons must be pointed out. Students should work with examples of the broader implications. Such active use of the insights will thereby become part of their thinking and the way they look at the world around them.

For Further Reading

- Alfeld, Louis Edward, and Alan K. Graham. 1976. *Introduction to Urban Dynamics*. Portland, OR: Productivity Press. 333 pp.
- Forrester, Jay W. 1961. *Industrial Dynamics*. Portland, OR: Productivity Press. 464 pp.
- Forrester, Jay W. 1968. *Principles of Systems*. (2nd ed.). Portland, OR: Productivity Press. 391 pp.
- Forrester, Jay W. 1969. *Urban Dynamics*. Portland, OR: Productivity Press. 285 pp.
- Forrester, Jay W. 1971. *World Dynamics*. (1973 second ed.). Portland, OR: Productivity Press. 144 pp. Second edition has an added chapter on physical vs. social limits.
- Forrester, Jay W. 1975. *Collected Papers of Jay W. Forrester*. Portland, OR: Productivity Press. 284 pp.
- Forrester, Nathan B. 1973. *The Life Cycle of Economic Development*. Portland, OR: Productivity Press. 194 pp.
- Foster, Richard O. (1970). *The Dynamics of Blood-Sugar Regulation*. M.Sc. thesis, M. I. T.
- Goodman, Michael R. 1974. *Study Notes in System Dynamics*. Portland, OR: Productivity Press. 388 pp.
- Hagen, Everett E. (1962). *On the Theory of Social Change*. Homewood, Illinois: Dorsey Press. 557 pp.
- Lyneis, James M. 1980. *Corporate Planning and Policy Design: A System Dynamics Approach*. Portland, OR: Productivity Press. 520 pp.

- Mass, Nathaniel J., ed., 1974. *Readings in Urban Dynamics: Volume I*, Portland, OR: Productivity Press, 303 pp.
- Mass, Nathaniel J. 1975. *Economic Cycles: An Analysis of Underlying Causes*. Portland, OR: Productivity Press. 185 pp.
- Meadows, Dennis L. 1970. *Dynamics of Commodity Production Cycles*. Portland, OR: Productivity Press. 104 pp.
- Meadows, Dennis L., et al. 1974. *Dynamics of Growth in a Finite World*. Portland, OR: Productivity Press. 637 pp.
- Meadows, Dennis L., and Donella H. Meadows, ed., 1973. *Toward Global Equilibrium: Collected Papers*, Portland, OR: Productivity Press, 358 pp.
- Randers, Jorgen, ed., 1980. *Elements of the System Dynamics Method*, Portland, OR: Productivity Press, 488 pp.
- Richardson, George P., and Alexander L. Pugh III. 1981. *Introduction to System Dynamics Modeling with DYNAMO*. Portland, OR: Productivity Press. 413 pp.
- Roberts, Edward B. 1978. *Managerial Applications of System Dynamics*. Portland, OR: Productivity Press. 562 pp.
- Roberts, Nancy, David Andersen, Ralph Deal, Michael Garet, William Shaffer. 1983. *Introduction to Computer Simulation: A System Dynamics Modeling Approach*. Portland OR: Productivity Press, 562 pages.
- Schroeder, Walter W., III, Robert E. Sweeney, and Louis Edward Alfeld, ed., 1975. *Readings in Urban Dynamics: Volume 2*, Portland, OR: Productivity Press, 305 pp.

